WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
H. L. RUSSELL, Dean.

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SOIL SURVEY

OF

MILWAUKEE COUNTY

WISCONSIN

BY

A. R. WHITSON, W. J. GEIB and T. J. DUNNEWALD

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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INTRODUCTION

Before the greatest success in agriculture can be reached, it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in coöperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the State, and to be of practical help to farmers by lo-

cating and describing the different soils, by determining their physical character and chemical composition, and by offering suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: first, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity and other physical properties of soil all depend chiefly upon *texture*, which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere. Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis*, which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.
Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.
Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Very fine sand.—Over 50% very fine sand.

Soils Containing Between 20–50% of Silt and Clay

Sandy loam.—Over 25% fine gravel, coarse and medium sand.
Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Sandy clay.—Less than 20% silt.

Soils Containing over 50% of Silt and Clay

Loam.—Less than 20% clay, and less than 50% silt.
Silt loam.—Less than 20% clay, and over 50% silt.
Clay loam.—Between 20 and 30% clay, and less than 50% silt.
Silty clay loam.—Between 20 and 30% clay, and over 50% silt.
Clay.—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the

different soils constitute merely a gradation in texture of otherwise uniform material, such a group is called a *soil series.* It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for example, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, where the parent rock was largely sandstone, and where the material occurs as outwash or stream terraces. The soils in this series also have a wide range in texture. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey. By uniting the soil class with the soil series we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unty, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF MILWAUKEE COUNTY, WISCONSIN

CHAPTER I. DESCRIPTION OF THE AREA

Milwaukee County is located in the southeastern part of Wisconsin. It is bounded on the north by Ozaukee County, on the east by Lake Michigan, on the south by Racine County, and on

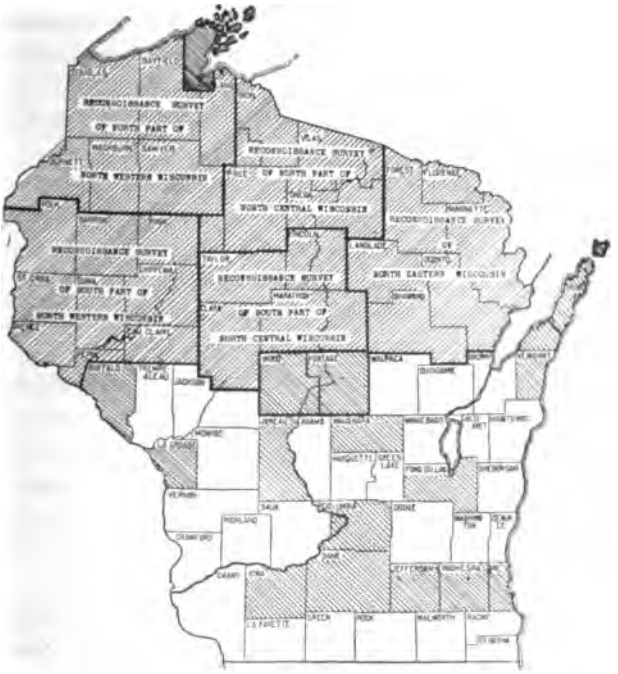

FIG. 1.—Sketch map showing area surveyed.

the west by Waukesha County. The city of Milwaukee is in the east-central part. The county varies from 8 to 12 miles in width east and west and is 24 miles long. It has a total area of 241 square miles, or 154,240 acres.

The topography of Milwaukee County consists of three low, broad, flat-topped, but rather distinct ridges running north and south parallel to the lake shore and separated by two shallow, narrow, lowland belts. All the ridges curve with the indentation of the coast line at Milwaukee, but elsewhere do not trend with the details of the coast line. Half of the first ridge has been removed between Milwaukee and the southern line of the county by the landward sapping of the lake, so that the lake shore lies approximately along the crest of the ridge, the height of the lake cliff, therefore, varying with the height of the ridge. North of Milwaukee the lake seems to have cut away about half of the ridge also. The remaining part of this ridge has a maximum width of about 3 miles in the northern part of the city of Milwaukee and at the northern boundary of the county. Elsewhere the width is half that or less.

The width of the first lowland ranges from a quarter mile locally at several places to expansions of more than a mile, as in the area of Peat west of Ryan, another southwest of Cudahy, and one near North Milwaukee. It lies about 40 feet lower than the top of the first ridge.

The second ridge has a width of about 5 miles throughout its course in the county. Its maximum elevation is about 140 feet and its general elevation about 80 feet above the lowland east of it. Its surface is undulating to rolling, owing to the existence of a number of subordinate ridges with the same trend as that of the main ridge.

The second lowland belt has a width about the same as that of the first belt. It lies about 100 feet below the general level of the top of the second ridge.

The third ridge, only the eastern part of which lies within the county, is essentially like the second.

The drainage system of the county consists of a number of small streams following the lowland belts and a few larger streams following the lowland belts in part and in part cutting their way across the ridges. In a few instances the small streams have cut valleys across low parts of the ridges. The Milwaukee River has cut a narrow valley across the western part of the first ridge west of Fox Point and across the eastern part in the northern part of the city of Milwaukee. The Menominee River has cut a narrow valley across the second ridge between Wauwatosa and the western part of the city of

Milwaukee and a broader one across the eastern ridge within the city. The Root River has cut a narrow valley across the second ridge where it runs in an eastward course along the southern boundary of the county, and Oak Creek crosses the first ridge in South Milwaukee. In those parts of their courses not mentioned above these streams occupy the lowland belts in a misfit way just like the small streams. The lawland belts were made before the existing streams were formed and by other forces. The local drainage is mainly into small basins, lakes, and ponds, and occasionally into the existing streams described above. The natural provision for the surface drainage of the county is very incomplete.

Milwaukee County was created in 1836. It then included a large area to the north, west, and south of the present county, and was not reduced to its present size until 1846.

The first settlers in the county were mainly English and French. Later German settlers largely occupied the northern and western sections. Subsequently German settlement spread to the southern part of the county, which had been occupied mainly by Irish. While the present population is largely German (about 60 per cent), it comprises many other nationalities. Many of the gardeners, especially south of Milwaukee, are of Polish descent.

The total population of Milwaukee County is reported in the 1910 census as 433,187. The rural population is given as 39,556, or about 9 per cent of the total, averaging about 168 per square mile. The density of the rural population of Milwaukee County is greater than that of any other county in the State. The density of population is greatest along the lake.

Milwaukee, with a population of 373,857, according to the 1910 census, is the county seat. Whitefish Bay, North Milwaukee, and Granville, in the northwestern corner of the county, Wauwatosa and West Allis, to the west of the city, and Bayview, St. Francis, Cudahy, South Milwaukee, and Carrollville, to the south of the city, are important towns. Hales Corners and St. Martins are located in the southwestern part of the county.

All the towns are connected directly by steam or electric railway with Milwaukee. The Chicago, Milwaukee & St. Paul Railroad has a double-track line from the city southward, and the Waukesha, Watertown, Fond du Lac, and Green Bay

branches running west and north. The Chicago & North Western has two double-track lines, one freight and one passenger, running south, and the Madison, La Crosse, Fond du Lac, and Manitowoc branches extending west and north from the city.

Of the electric interurban lines the Racine line of the Milwaukee Electric Railroad & Light Co. and the Chicago, Northshore & Milwaukee Electric Railway extend southward from the city, and the Troy and Muskego Lake lines of the former system westward to West Allis and south through Hales Corners and St. Martins. The Waukesha & Watertown line of the same system runs west and the Milwaukee Northern Electric Railway north from the city.

Owing to the heavy, clayey nature of the soil over the greater part of the county, the roads in their natural condition are very bad in wet weather, and with the rapid increase in the use of the automobile it became necessary to build roads capable of withstanding the heavy traffic in the vicinity of the city. In the last few years nearly all the main roads and many of the crossroads have been surfaced. A report of the Milwaukee highway department published in January, 1916, indicates that nearly 100 miles of permanent road had been completed outside the city, 86 per cent being concrete, 7 per cent asphalt, 2 per cent brick and blocks, and 5 per cent macadam. The cost is met by direct taxation, about one-third being borne by the State. About $2,000,000 has been expended. The road improvements have had a marked effect in increasing land values.

The city of Milwaukee is the chief market for all garden crops and many other products, such as milk, butter, meat, hay, grain, potatoes, etc. Sugar beets, some of the milk, cabbage, and other products are shipped to outside markets.

SOILS

Milwaukee County lies entirely within the glaciated area, and the surface formation consists of glacial deposits, ranging in thickness from a few feet to almost 200 feet. The soils have been derived, through weathering, from the drift materials, either in the position in which they were left by the ice or after transportation and redeposition by water.

With the exception of a small strip along the lake shore north of Milwaukee, the county is covered by drift deposited during

the late Wisconsin stage of glaciation. This material was laid down in long gentle ridges parallel to the lake shore, with intervening narrow lowland belts and inclosed depressions, which exist as poorly drained areas and marshes. A study of the rock fragments found in the drift shows that 80 to 90 per cent is of limestone similar to the rocks underlying the drift. The remaining 10 to 20 per cent is composed of rock fragments wholly foreign to this part of Wisconsin. This small quantity of foreign material is made up of rocks brought from localities farther north and similar to those now exposed in the Lake Superior region, including Archaen crystalline rocks and the older sandstones and quartzites. The drift as originally deposited was for the most part unassorted and consisted of a blue, gray, or brown clay or silty clay in which sand, gravel, and bowlders of various sizes were embedded. It was highly calcareous, being derived largely from limestone.

Since the final recession of the ice this material has been subjected to the process of weathering, giving rise to productive soils. The principal changes that have taken place are the leaching from the surface soil of the lime and other readily soluble constituents, and the incorporation of organic matter. Leaching has proceeded so far in many places that the surface soil is neutral or even acid. In most cases, however, there is a larger quantity of lime in the subsoil. The color of the upper part of the drift below the dark surface soil has been changed to a yellowish brown by oxidation. The surface soil has been darkened to a greater or less extent by the incorporation of organic matter. The drift soils are classed with two soil series—the Miami and the Carrington.

North of Milwaukee, lying between the Milwaukee River and the lake shore, there is a deposit of red material which differs strikingly from the other surface deposits of the county. The exact time and manner of its deposition has not been fully determined. Its position overlying the drift and stratification in places indicate deposition in comparatively still water, but the source of the red material is not known. The thickness of this deposit varies from about 1 foot to 80 feet, with an average of about 25 feet. It occurs as a series of broad, gently undulating ridges. The unweathered material is a silty clay varying in color from light red to brownish or purplish red. In places many bowlders are present, but as a rule these are less abundant

than in the other surface materials of the county, and over considerable areas they are rarely encountered. Weathering does not extend to so great a depth as in the other materials, and organic matter does not seem to accumulate so rapidly in the surface soil. The soils of the Superior series are derived from this deposit.

The terrace soils are principally derived from deposits that were laid down as outwash plains by swollen streams from the melting glaciers. The most extensive terraces occur along Milwaukee River just north of Milwaukee. Similar terraces border other large streams in the county. The surface covering of the terraces ranges from a clay loam to sand, beneath which lie coarser materials. During the ice invasion some areas, principally along stream valleys, were ponded by the drift, and the lowlands thus formed were filled at the time or later by alluvial material. Through work of streams these valleys have been trenched and the remnants left as well-drained terraces or only partially drained areas and poorly drained tracts or marshes where more or less vegetable matter has accumulated. Several series of soils are represented.

The various soils are grouped, on the basis of origin and formation, color, topography and drainage, and other features, into soil series. The series is subdivided into types on the basis of texture. Sixteen types, included in eight series, exclusive of Peat, are mapped in Milwaukee County.

The soils of the Miami series are grayish brown, and the subsoils yellowish brown. The subsoils are heavier in texture than the soils, but the lower subsoils and substrata may be gravelly and sandy. These soils are derived from drift, and bowlders, mainly of limestone, occur in the soil and subsoil. The surface soil may be neutral or even slightly acid, but the subsoil usually is calcareous. In this county five types are mapped, the fine sandy loam, loam, silty clay loam, gravelly clay loam, and clay loam.

The soils of the Clyde series are dark gray or dark brown to black; the subsoil is gray or drab, mottled with yellow. The Clyde soils are poorly drained and occur along streams and marshes within areas of the Miami series. They represent gracial-drift material reworked in part by streams and weathered under poor conditions of drainage. In this county the loam and clay loam types are mapped.

The soils of the Carrington series are dark brown to black. The subsoil is yellow to light brown. The series is derived by weathering from glacial till. The topography is undulating to rolling. Neither the soil nor the subsoil is highly calcareous. The series is represented in this county by a single type, the silt loam.

The soils of the Superior series are brown to reddish-brown at the surface with red subsoils. The series has been derived largely from red lacustrine material which was reworked by glacial action after its deposition by water. The topography varies from level to rolling. Two phases were recognized and mapped, the only difference being in topography. The level phase is level, and consequently somewhat deficient in natural drainage, while the rolling phase has fair to good natural drainage. The Superior clay loam, rolling phase, and the Superior fine sandy loam were the types mapped.

The soils of the Poygan series are black. They contain large quantities of organic matter. The subsoil is red and similar in character to that of the Superior series. As a rule, these soils are poorly drained. In this county the series is represented by only one type, the clay loam.

The Fox series includes grayish-brown soils with yellow or yellowish-brown subsoils, heavier in texture than the surface. Layers of sand and gravel, composed mainly of limestone, often occur below about 30 inches. These soils occupy level terraces. They lie above overflow, and drainage usually is good. In this county the Fox fine sandy loam and silt are mapped.

The Waukesha soils are dark brown to almost black, with light-brown or yellow subsoils. Layers of sand and gravel are encountered in places in the deep subsoil or substratum. The soils of this series occur on level or gently undulating terraces and are well drained. The sandy loam and loam types are mapped in Milwaukee County.

The Plainfield series includes brown surface soils with light-brown sandy and gravelly subsoils. These are productive terrace soils, but are somewhat droughty in very dry seasons. The Plainfield fine sand is mapped in this area. It is not typical, but is made to include all the sand areas in the county.

Peat, as mapped in this county, consists of a dark-brown to black spongy mass of organic matter made up of partly decayed vegetation. The peaty material varies greatly in depth,

and a shallow phase of the type is separated. The depth of the peaty material in the shallow phase ranges from about 3 to 18 inches; in the typical areas it is more than 18 inches deep.

The following table gives the name and the actual and relative extent of each soil type mapped in Milwaukee County:

Areas of different soils.

Soil	Acres.	Per cent.	Soil	Acres	Per cent.
Miami silty clay loam...	55,296	37.7	Carrington silk loam...	1,408	.9
Level phase.....	2,752		Clyde loam.....	1,152	.7
Miami clay loam.....	38,528	30 3	Miami gravelly clay loam.....	1,088	.7
Level phase.....	8,384		Waukesha loam.....	1,024	.7
Clyde clay loam.....	19,392	12.6	Fox fine sandy loam....	832	.5
Superior clay loam, rolling phase.....	9,280	6.0	Fox silt loam.....	576	.4
Miami loam.....	5,248	3.4	Superior fine sandy loam	448	.3
Peat.....	2,880	2.2	Poygan clay loam.....	384	.2
Shallow phase.....	448		Plainfield fine sand.....	64	.1
Miami fine sandy loam..	3,200	2.1	Total.....	154,240	.....
Waukesha sandy loam...	1,856	1.2			

CHAPTER II.

GROUP OF HEAVY SOILS

Miami Clay Loam

Extent and distribution. The Miami clay loam is the second most extensive soil in Milwaukee County. It covers 30.3 per cent of the county or a total of 46,912 acres.

This soil as mapped includes a large part of the upland of the north half of the county. It includes the undulating to rolling upland south of the Menominee River and the more rolling ridges west of Wauwatosa and along the east side of the Underwood Creek Valley.

Description. The Miami clay loam consists of 4 to 8 inches of grayish-brown, compact clay loam or silty clay loam, overlying yellowish-brown to reddish-yellow heavy clay loam or clay. Yellowish-brown sandy clay loam or loam occurs at depths of 22 to 30 inches. From 30 to 36 inches the material contains some gravel and often considerable sand. On the knolls the gravel may be nearer the surface with a sticky gravelly clay or loamy clay surface soil. Depressions and level areas have a deeper silty surface soil.

Areas to the south, where the surface silty material is uniformly deeper over the clay loam subsoil, are mapped as the Miami silty clay loam. In general the clay loam occupies the more rolling ridges, but the separation of the clay loam and silty clay loam types is difficult, and the boundary between the two is in many cases largely arbitrary. The difference in the soil is most noticeable in wet weather when the rolling ridge land, where the surface silty clay is shallower, often becomes difficult to work. In dry weather the difference is not so marked and the separation of the types on the basis of the depth of the silty surface layer is difficult.

Topography and drainage. The surface of this soil varies from undulating to rolling, and the natural surface drainage is in most cases good. There are some level and very gently undulating tracts within the type, and where of sufficient extent these have been separated and shown on the soil map as a level phase of the type. Over these areas the natural drainage is somewhat deficient on account of the heavy subsoil, and tile drains could be used to advantage in such places.

Origin. This soil is of glacial origin, having been derived largely from the underlying limestone through the action of weathering and ice movements. While most of the material came from limestone the surface is thoroughly leached, and a slightly acid condition frequently prevails. In the subsoil, however, it is common to find varying amounts of lime carbonate.

Native vegetation. The original forest growth consisted of oak, maple, elm, ash, beech, and some hickory and walnut. But little of the valuable timber is left.

*Present agricultural development.** This is an extensive and highly developed soil. The soil is strong and productive, and except for small woodlots it is practically all under cultivation. The original forest growth consisted of oak, maple, elm, ash, beech, and some hickory and walnut, but little of the valuable timber is left. The type is used mainly for dairying and general farming combined. In trucking and gardening sections and along some of the main roads leading into Milwaukee garden crops are produced. The general farm crops include corn, oats, barley, hay, potatoes, cabbage, and sugar beets, with some alfalfa.

Corn yields 80 to 100 bushels, oats 60 to 70 bushels, barley 40 to 50 bushels, potatoes 125 to 150 bushels, sugar beets and cabbage 15 to 20 tons, and alfalfa 3 to 4 tons of hay per acre. Alfalfa is not grown on many farms, but its acreage is increasing. No great difficulty seems to be experienced in getting a good stand where proper methods are employed. Cabbage, potatoes, and sugar beets are the cash, or special crops on this type. Little hay, corn, or grain is sold, most of these crops being fed to cows, hogs, and other stock.

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* For chemical composition and improvement see page 29.

VIEW REPRESENTING THE SURFACE FEATURES OF MIAMI CLAY LOAM AND MIAMI SILTY CLAY LOAM

These are the two most extensive and important soils in Milwaukee County, there being a total of over 100,000 acres.

VIEW OF THE NORTH SIDE OR POPLAR STREET MARKET, MILWAUKEE.

There are four such markets in the city which do a total business during the summer six months of over $650,000.00.

Barnyard manure is applied to this soil, and manure spreaders are in common use. Very little commercial fertilizer is used but a gradually increasing number of farmers are testing it out with results which are certain to lead to an increased use of these fertilizers.

This land sells for $200 to $400 or more an acre, depending upon location and improvement.

Miami clay loam, level phase. This phase includes areas of the Miami clay loam having a nearly flat topography. The soil consists of 6 to 8 inches of grayish-brown silty clay loam overlying a yellowish-brown or mottled yellow clay or clay loam. Sandy clay loam with some limestone fragments is reached at about 30 to 36 inches.

This phase occupies irregular areas in the broad valleys or depressions between the ridges, and generally borders a stream or marsh. It occurs mainly in the north half of the county.

The surface is generally flat, and while some areas have fair drainage, others after periods of wet weather remain much too wet for cultivation. The poor drainage is partly due to seepage from surrounding higher land.

Practically all this phase is cultivated or pastured, about the same crops being grown as on the main type. Yields are somewhat lighter, and cultivation is often delayed in the more level areas. For its improvement this soil requires drainage, generally by means of tiling, and in some places liming is essential.

Miami Silty Clay Loam

Extent and distribution. This soil is the most extensive in Milwaukee County, covering 37.7 per cent of the county or a total of 58,048 acres. It is confined almost entirely to the south half of the county where it is the predominating soil.

Description. The Miami silty clay loam consists of dark grayish-brown, compact silt loam, 6 to 10 inches deep, and sometimes containing a relatively large proportion of very fine sand, resting on a subsoil of yellowish-brown clay loam. The material is reddish-brown and contains limestone fragments below a depth of 24 to 36 inches. Small areas in which the silty soil is about 8 inches deep and which might for that reason be mapped as a silt loam are included.

In a few places limestone rock occurs at 5 to 10 feet below the surface, but it is usually much deeper. Some stony spots occur in the southwestern part of the county and are indicated by symbols. In the southeastern corner of the county the land is said originally to have been stony, but the stones have largely been removed and only a few bowlders remain on the surface.

Topography and drainage. The surface of this soil is gently rolling and the natural surface drainage is good. In some places the surface is level to very gently undulating and in such places this condition has been indicated on the soil map as a level phase. Over this portion of the type the natural drainage is somewhat deficient. Tile drains could in many cases be used to advantage.

Origin. The material forming this soil is of the glacial origin and has been derived largely from the underlying limestone through weathering and glacial action. The subsoil contains varying amounts of lime carbonate, but in most cases this has been quite thoroughly leached from the surface soil, and frequently a slight acid condition has developed.

Native vegetation. Most of the type in its native state was forested with a heavy growth of hardwood, with "oak openings," or areas of scattered trees, in places. The timber remains only in small woodlots, and practically all the type is under cultivation.

*Present agricultural development.** The Miami silty clay loam is used mainly for dairying and general farming, but along Kilbourn and New Roads and Howell Avenue south from Milwaukee, and also along Janesville Plank and Loomis Roads considerable gardening is done. Hillside slopes, where the soil is often slightly loamy, sandy, or gravelly, and small strips of darker soil at the heads of drainage ways or bordering creeks and marshes, are preferred for the garden and truck crops. The farms are generally smaller and the land higher priced along these main roads.

On the dairy farms the most important crops are corn, barley, oats, hay, clover, and potatoes, with some alfalfa. Corn yields 80 to 100 bushels, oats 40 to 60 bushels, and potatoes 100 to 150 bushels per acre. Most of these crops are fed to the cows. The cash products include milk and butter, calves, hogs, and small quantities of grain, corn, and hay.

* For chemical composition and improvement see page 29.

The crops are grown in rotation, the usual plan being as follows: (1) Clover hay, (2) clover and timothy hay, (3) corn or potatoes, and (4) grain, seeding the land to clover and timothy. Barnyard manure is relied upon to maintain the soil in productive condition. A few farmers are beginning to use commercial fertilizers though the practice is not at all common as yet. Some of the farmers combine dairying and gardening, keeping a few cows and raising some garden crops with enough field crops to feed the stock.

Land of this type varies widely in price, garden farms along the main roads selling for $300 to $500 an acre, while dairy farm and lands in more remote areas sell for $100 to $300 an acre, depending upon improvements, character of the surface, and the condition of the land.

Miami silty clay loam, level phase. The surface soil of this phase consists of a grayish-brown heavy silt loam or silty clay, underlain at 6 to 10 inches by yellowish-brown clay loam. A sandy gravelly clay or sandy loam is encountered at 30 to 40 inches. The topography is very gently undulating to level. This phase does not include so much wet land as the level phase of the Miami clay loam, and as a whole is better drained.

Practically all the phase is under cultivation. It is used for the production of general farm crops. Corn yields 60 to 70 bushels, oats 50 to 70 bushels, and potatoes 150 to 200 bushels per acre. Alfalfa does well, although in wet seasons it may become weedy.

Land of this phase sells for $125 to $300 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Miami silty clay loam:

Mechanical analyses of Miami silty clay loam.

Description	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Soil	1.5	4.2	4.0	20.0	10.9	48.7	10.6
Subsoil	.8	3.6	3.8	20.1	10.5	43.7	17.5

Mechanical analyses of Miami Silty clay loam.

MIAMI GRAVELLY CLAY LOAM

This soil covers only .7 per cent of the county or a total area of 1,088 acres.

Most of the type occurs in a nearly continuous, gravelly morainic area extending from Lake Michigan, one-half mile north of Cudahy, in a northwesterly direction through St. Francis to a point west of Bay View. Another area lies south of the Menominee River, near the west end of the viaduct just west of Milwaukee. A few small areas occur in other parts of the county.

The Miami gravelly clay loam is somewhat variable in texture. The soil prevailingly is a grayish-brown or yellowish-brown, sticky or compact clay loam or sandy clay loam, containing varying quantities of sand and gravel. The subsoil is generally a compact clay loam or sandy clay loam carrying some gravel. Gravelly sandy loam occurs in places at 20 to 36 inches, and in some areas gravel is strewn thickly over the surface.

Areas of sandy gravelly loam, too small to be mapped separately, are included with this type. They occur on small, scattered knolls in the moraine south of Bay View.

The topography is generally undulating to rolling or bumpy, and the drainage is good to excessive.

The material forming this soil is found chiefly in the form of a moraine, and consists of a mixture of clay, sand, and gravel, much of which has been derived from the underlying limestone rock. Considerable lime carbonate is found in the subsoil and also in the soil and the type is not acid.

This soil was originally timbered with hardwoods common to the region, but most of the timber has been removed and the land improved. In a few instances woodlots still remain.

Areas of this soil near the city are used for gardening and for the production of the general farm crops. The soil is very productive. It is often rather difficult to work because of the gravel, and much of it farther removed from the city is used for pasture or woodlots. Near Milwaukee a number of gravel and sand pits are worked in areas of this type.*

* For chemical composition and improvement see page 29.

SUPERIOR CLAY LOAM, ROLLING PHASE

Extent and distribution. This soil is one of the important types in Milwaukee County. It covers 6 per cent of the area, or a total of 9,280 acres. It occurs as a continuous body, lying mainly between Milwaukee River and Lake Michigan. This area is about 3 miles wide along the north county line and tapers rapidly to the south. At Whitefish Bay the area extends less than one-fourth mile back from Lake Michigan, but it widens again farther south. It is cut by the valley of the Milwaukee River. A small isolated area lies on the lake a short distance north of Cudahy.

Description. The surface soil of this type consists of grayish-red or reddish-brown clay loam from 3 to 6 inches deep, containing a fair percentage of organic matter and varying quantities of gritty sand or fine sand. The subsoil is a red, sticky, compact clay loam, which continues throughout the 3-foot section and contains varying quantities of limestone fragments and gravel. Where the land is slightly undulating the soil of the knolls has a pink or reddish color, while grayish material predominates in the level areas. The knolls and undulating areas, although having better drainage, are often as hard to work in wet seasons as the level areas where the surface material has greater depth.

Topography and drainage. Most of the type has a gently undulating topography. Along the east side of the Milwaukee River Valley the surface is distinctly rolling, and an abrupt bluff extends 100 to 120 feet down to the lake. A few deep ravines extend back one-half to 1 mile from the lake. Some areas of the type are nearly level. Shallow swales and narrow depressions occur along the drainage ways, and some small undrained depressions and flat areas occur, in which the surface has become dark from the accumulation of organic matter. This undrained soil, where of sufficient extent to be shown separately on the soil map, is classed with the Poygan clay loam. Drainage is poorest in the widest part of the area just below the north county line. The dense clay subsoil makes the soil rather cold and late, especially in wet seasons, where the topography is not distinctly undulating or rolling.

Origin. The Superior clay loam is largely of lacustrine origin having been deposited in quiet waters, probably during

interglacial times, and later reworked by glacial ice. The movement of the ice ground up much of the underlying limestone and mixed this with the material which had been deposited by water, so that this soil, especially in the lower portions is well supplied with lime carbonate. The surface soil, having been leached quite thoroughly, has in places developed a slightly acid condition.

Native vegetation. The original timber growth consisted of oak, maple, elm, beech, with some hickory and a little walnut. Only a few wood lots remain and even from these the best timber has been removed.

*Present agricultural development.** Practically all the type is under cultivation or used for pasture. Grain, corn, and hay are the chief crops. Dairying is important. On some of the small farms a few cows are kept and butter is sold, while the larger farms with more cows sell whole milk. A number of farms, especially those including low areas of dark soil, produce truck crops to some extent. Cabbage, tomatoes, potatoes, and other garden crops are grown, although the soil as a whole is not well adapted to gardening, being too heavy to work easily and too slow in drying after rains.

Corn is not extensively grown, and in most years only the earliest varieties mature well, because planting in the spring is often delayed. Replanting is frequently necessary in wet seasons. Forty to fifty bushels per acre is considered a good yield of corn. Oats yield 30 to 40 bushels, potatoes 60 to 80 bushels, rye 15 to 20 bushels, timothy about 1½ tons, and timothy and clover mixed 1½ to 2½ tons per acre. Irish potatoes are grown for home use, but the industry has not been developed on a commercial scale. The type is better adapted to other crops than to potatoes. Considerable difficulty is experienced in obtaining and keeping a stand of clover, and over some sections little clover is grown.

The Superior clay loam is somewhat difficult to cultivate, and requires heavy stock and implements to handle it efficiently. When plowed too wet it is likely to puddle. On knolls of heavier soil large clods are sometimes turned up which are quite difficult to pulverize. The poorly drained areas are more difficult to handle than where the drainage is good. The best re-

* For chemical composition and improvement see page 29.

sults are obtained where the land is plowed in the fall, but fall plowing is not always practicable. Stable manure is applied to this soil, but green manuring is not common. Commercial fertilizer is used only to a limited extent at present.

The following table gives the results of mechanical analyses of samples of the soil and subsoil:

Mechanical analyses of Superior clay loam, rolling phase.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent*	*Per cent.*	*Per cent.*	*Per cent.*
Soil	0.3	1.7	2.6	13.9	11.0	39.8	30.6
Subsoil	.4	1.6	1.9	12.0	11.6	38.5	34.2

CARRINGTON SILT LOAM

This type of soil occupies only .9 per cent of the county or a total of 1,408 acres. It is confined to the southwestern part of the county in Franklin Township and joins a much larger tract in Racine County to the south.

The Carrington silt loam consists of 10 to 16 inches of dark-brown or black heavy silt loam overlying a buff or grayish-brown clay loam. The subsoil contains small quantities of fine sand and gravel, and is light yellow below about 24 to 30 inches. White streaks of limy or marly material are present in a few places in the deeper subsoil. The soil is mapped in the southern part of the county.

The topography is undulating to gently rolling. The type includes lower-lying areas near the streams and steep slopes rising to the highland. Although there is considerable variation in the topography, the drainage is generally deficient, and tile drainage is required over a large part of the type to bring it to its highest state of productiveness. Small grassy swales and depressions are numerous, and because of the dense clay subsoil and the lack of natural drainage outlets, the type includes considerable wet and cold waste land that can be reclaimed only by drainage. Even land with considerable slope may be too wet for satisfactory cultivation. Probably 50 per cent of the type would be benefited by the installation of tile drains.

Notwithstanding the deficient drainage of this type, it is a productive and valuable soil. All of it is used for some purpose, the wet land for hay or pasture. Little if any of the original forest remains.

General dairy farming is practiced, and some truck crops are grown. The most important crops are corn, barley, hay, potatoes, and cabbage. Corn yields 60 to 100 bushels per acre, barley 25 to 40 bushels, hay about 2 tons, potatoes 100 to 150 bushels, and cabbage 12 to 15 tons.

A sufficient number of cows is generally kept on the farm to supply the cultivated land with barnyard manure. No commercial fertilizers are used either on the general farm crops or on the truck crops.*

Fox Silt Loam

The Fox silt loam is of very limited extent in this County, covering only .4 per cent of the area, or a total of about 576 acres. This soil occurs chiefly along the Root River in the southern and southwestern portion of the County.

The Fox silt loam consists of 8 to 12 inches of grayish-brown silt loam, underlain by yellowish-brown, compact silty clay loam containing some gravel. Yellowish-brown sandy loam occurs at 24 to 36 inches or at greater depths.

As mapped, this type includes areas of loam, which are not sufficiently extensive to be mapped separately. The loam occupies the areas along Root River and the greater part of the area on Underwood Creek west of the State Fair Grounds. The surface soil consists of 8 to 12 inches of grayish-brown loam to silty loam, containing varying quantities of sand and some gravel. The subsoil is a yellowish or reddish-brown, sticky sandy clay loam or loam. A reddish-brown sandy gravelly loam occurs at 24 to 30 inches, and this is underlain by gravel and sand.

The surface is level, or having only a gentle slope toward the stream along which it occurs. In most cases the natural drainage is fair to good, though in a few places tile drains could be installed to advantage.

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* Chemical composition and improvement of this soil discussed on page 29.

This is an alluvial soil and was deposited largely by the streams when much higher than at present. The parent material is of glacial limestone origin, but the surface soil has been leached to such an extent that the lime carbonate has been removed and an acid condition has developed in places.

This soil is used chiefly for general farming, and all of the general farm crops common to the region are grown upon it with success. Land of this kind sells for from $150 to $300 per acre depending upon its location and improvements. The areas near Milwaukee would of course have a much higher value.

Chemical Composition and Improvement of Group of Heavy Soils

There are a number of types in this County which are so closely related in texture, structure, and agricultural possibilities, that from the standpoint of improvement and management they may be considered in groups, rather than as individual types.

The types of soil in this group are much alike in certain chemical respects, though each has its individual characteristics in other respects. They run rather high in the mineral elements, potassium, calcium, and magnesium. The surface 8 inches will average about 1,100 pounds of phosphorus per acre, which is higher than in the sandy and sandy loam groups of soils, but it is considerable lower than it is desirable to maintain in a highly productive soil.

In potassium there is considerable variation. These types, especially in the subsoil are very rich in this element. The average amount in the surface 8 inches per acre is approximately 53,000 pounds. Fox silt loam is somewhat lower; but all have sufficiently abundant supplies of this element to supply all heavy crops when the soil contains the necessary amount of actively decomposing organic matter to render it available.

In nitrogen and organic matter there is more variation. Most of these soils have a rather small amount of organic matter and consequently small amounts of nitrogen, the average being less than 3,000 pounds per acre in the surface 8 inches. Carrington silt loam, on the other hand, as its color indicates, has a much larger amount of organic matter and nitrogen, the average being somewhat more than twice that in the other types

of soil. It must be remembered, that even dark prairie soils which have been cultivated for a number of years without the use of manure or other vegetable matter will lose the most active part of their organic matter, and even though they still retain enough to give them a good dark color, the organic matter is of a resistant character, and the nitrogen and inorganic matter—phosphorus, potassium, and calcium—do not become available to crops with sufficient rapidity. Moreover, the large crops which these soils have usually produced for a number of years after being first broken have frequently exhausted the more readily available phosphorus to such an extent that the development of a high degree of fertility in them now requires the use of some form of phosphate fertilizer as well as the use of a system of rotation and manuring which will supply the necessary active organic matter.

The supply of calcium carbonate in all of these types of soil was originally very large on account of their formation in large part from limestone rock by the grinding action of glaciers. Their subsoils still contain large amounts of lime and magnesium carbonate, with the exception of that of the Fox silt loam, which has in the subsoil only moderate amounts of this material. The surface of these types, hwever, have been subjected to leaching for thousands of years and this has, to a considerable extent, removed the carbonate from the surface 6 to 12 inches, so that acidity has developed in patches over this entire section. This is particularly true of the Carrington silt loam, the larger amount of organic matter of which has caused a larger solution of the carbonate than occurred in other soils containing smaller amounts of vegetable matter. Farmers having difficulty in getting a good catch of clover or alfalfa should test their soil for acidity. The large supply of lime carbonate existing in the subsoils of practically all of the area covered by the four types named will undoubtedly greatly lessen the amount of time which may be needed to maintain them in a sweet condition.

In the management of these types it should be kept in mind that, with the exception of the Carrington, the surface soil of all of the types in this group is light colored and deficient in organic matter. An effort should be made to gradually increase the supply of organic matter by supplementing the stable manure with green manuring crops. Legumes are best for this purpose. The plowing under of such crops will tend to loosen

the heavy soil, and more nitrogen will be supplied than if other crops are used.

Wherever an acid condition is sufficiently marked to interfere with the growing of crops, ground limestone should be applied at the rate of from 2 to 3 tons per acre. These types will also respond to applications of rock phosphate. This may be applied at the rate of 500 to 600 pounds per acre for the first application, and about half this amount once during each rotation.

Where the raw rock phosphate is used it should be applied along with manure or a green manuring crop. It may be spread upon the top of a loaded manure spreader, and applied in this way, or the row rock may be scattered in the stables behind the cattle and mixed with the manure in this way. Acid phosphate may also be used, and is much more quickly available to the growing plants. This may be applied through a fertilizer attachment to a grain drill or corn planter or it may be applied with the manure as a top dressing, but it should not be plowed under. From 200 to 300 pounds per acre is considered a good application for general farm crops. Where it is desired to give grain or other crops a quick start a mixed fertilizer containing nitrogen may well be used. A fertilizer analyzing 2–10–0 or 2–12–0 is well suited to this purpose. In normal times some potash may be added to this formula with profit.

Where trucking is carried on on these soils very large amounts of stable manure are commonly used. This manure is not in itself a well balanced fertilizer, being deficient in both phosphorus and potassium. Equal or better results could be secured, and secured more economically, by using a smaller amount of the manure and supplementing this with mixed fertilizers containing all three of the elements, nitrogen, phosphorus, and potassium. Under intensive methods from 500 to 1,000 pounds of commercial fertilizer can be used with profit, and in many trucking regions even greater amounts are used. Rotation of crops in trucking is necessary as it checks and tends to prevent the spread of disease. The rotation should include a legume crop that is plowed under. This will increase the nitrogen and organic matter supply and reduce the necessity for large applications of manure, through which many weed seeds are often brought to the farm.

Careful attention should also be given to crop rotations when general farming is practiced, and efforts should be made to follow only such a system as will tend to increase, or at least maintain, the soil fertility. Thorough cultivation is more important on these heavy types than on the lighter soils of the county. Fall plowing, especially of sod, is advisable where there is no danger of erosion. The seed bed should always be carefully prepared, and with intertilled crops, such as corn, a good mulch should be kept, to check the loss of soil moisture. The growing of alfalfa could be profitably extended, and some special crops, including peas, could well be raised more extensively.

CHAPTER III.

GROUP OF LOAMS AND FINE SANDY LOAMS

Miami Loam

The Miami loam covers 3.4 per cent of Milwaukee County or 5,248 acres. It is found in nearly all parts of the county in small patches. The largest tract occurs at Bay View, just south of Milwaukee. Another area is found at South Milwaukee.

The surface soil consists of 6 to 10 inches of yellowish or brownish-gray loam to fine sandy loam, and the subsoil differs very little from the soil. At 24 to 30 inches the material is a more compact, sticky yellowish-brown sandy clay loam or loam. Gravelly sandy loam is often encountered at 30 to 36 inches. The soil is slightly variable, being a sticky sandy clay loam in some places and a more open sandy loam in others. Gravel sometimes occurs on sharp knolls, and bowlders originally were quite numerous, though most of these have been removed. This soil is intimately associated with the Miami clay loam and silty clay loam, and in places the boundary is arbitrary.

The type occupies undulating to rolling tracts of land, and is frequently found as knolls and narrow strips or projections of high land bordering streams or marshes. The larger areas are undulating to rolling, and the natural drainage is almost always good. On account of varying amounts of coarse material in the subsoil in the form of fine gravel and particles of sand, water moves through the subsoil more readily than through the subsoil of the Miami clay loam, and silty clay loam, and the internal drainage is therefore better.

As indicated elsewhere this soil has been formed from glacial material which was derived largely from the underlying limestone. Because of its origin the soil is usually not acid, though a slight degree of acidity is sometimes found in the surface soil. The subsoil contains considerable amounts of lime carbonate.

A few areas are still forested but the greater portion of this soil is under cultivation and highly improved. Where not occupied by city buildings, the type is devoted to general farming, and some truck growing. It is a good soil and is better suited to trucking than the Miami clay loam and silty clay loam soils. The general farm crops are most commonly grown and average yields secured are corn 50 to 70 bushels, oats 40 to 50 bushel, potatoes 100 to 150 bushels and hay 1½ to 2 tons per acre. Barley, and a small amount of wheat are also grown, good yields are secured. Barnyard manure is the chief fertilizer used, though more consideration is now being given to the use of commercial fertilizers.*

The selling price of this land varies widely. Some of it near Milwaukee sells for as much as $600 to $1,000 an acre, while in more remote areas it can be bought for $100 to $200 an acre.

Miami Fine Sandy Loam

This soil covers 2.1 per cent of the county or a total of 3,200 acres. This type occurs in isolated areas in all parts of the county. The areas vary in size from a few acres to a square mile or more. The largest areas are near St. Francis, northeast of South Milwaukee, near and west of the Blue Mounds Country Club, and just east of North Milwaukee.

The surface soil of the Miami fine sandy loam consists of 8 or 10 inches of grayish-brown to yellowish-brown fine sandy loam overlying yellowish-brown, sticky sandy clay loam or sandy loam. Gravelly sandy loam or sandy clay loam is encountered at a depth of 24 to 30 inches. The gravel occurs at or near the surface on the knolls, while in the depressions the surface soil is deeper and heavier than the average.

A sandy loam variation occurs along the Kinnikinnic River in the Southwestern part of Milwaukee and along Underwood Creek, near the western county boundary.

The topography is generally undulating to rolling, and the drainage is good. On the sharpest knolls where gravel occurs near the surface crops may suffer from drought in continued dry spells, but the soil in general holds moisture well and produces good crops.

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* For chemical composition and improvement see page 37.

As with other types of the Miami series this soil is of glacial origin, having been derived largely from the underlying limestone, and possibly in part from glacial material transported from the north, and coming from other sources than limestone. While some limestone gravel is found the surface soil has been leached to such an extent that practically all of the lime carbonate has been removed, and an acid condition has developed over a considerable porion of the soil.

This soil was originally timbered, chiefly to hardwoods. Practically all of the timber has been removed and the soil improved. Most of the type near the more thickly settled sections is used for trucking and gardening, and is well suited to that purpose, as it is easily worked and well drained. Its uneven topography and lack of organic matter, however, make it somewhat inferior to the Clyde and Waukesha soils. In addition to garden and truck crops, it produces good yields of sugar beets, oats, potatoes, and corn. Liberal applications of manure are needed on this soil and are usually given. The use of the commercial fertilizers is not a common practice, but the satisfactory results secured in an experimental way on this and other soils tend to gradually increase the use of commercial fertilizers.*

Superior Fine Sandy Loam

The Superior fine sandy loam is of very limited extent and of minor importance. It occupies only .3 per cent of the county or a total of about 448 acres. It occupies a strip about ¼ mile wide along the Lake Michigan shore just south of Milwaukee.

The surface soil of the Superior fine sandy loam, to an average depth of about 12 inches, usually consists of a brown or yellowish-brown fine sandy loam, the color becoming lighter with depth. The texture varies somewhat, and in local areas may be a sandy loam or sand. The upper subsoil has about the same texture as the soil, but a stiff red clay is encountered at depths of 20 to 40 inches. The surface is gently undulating, and the natural drainage is good. Because of the heavy subsoil moisture is retained well by this type.

The heavy red clay subsoil of this type is of lacustrine origin, and has doubtless been influenced to some degree by glacial

* Discussion of chemical composition and improvement of this soil on page 37.

action. The surface sandy material was probably carried from a greater distance by the ice sheet and deposited over the red clay when the ice receded. The soil was originally timbered chiefly to hardwoods, but practically all of this timber has been removed.

Much of the type is now used for building sites. Where cultivated, it is utilized chiefly for general farm crops—corn, oats, barley, rye and potatoes. But little hay is grown. Good yields of these crops are secured, but because of the sandy nature of the surface, and the location this soil is better suited to the raising of truck crops. It should be devoted entirely to intensive methods of farming. Because of its location the entire type will doubtless be used in time for building sites.*

Fox Fine Sandy Loam

This is also one of the limited soil types of the area. It has a total extent of only 832 acres. It occurs chiefly along the Milwaukee River north of Milwaukee, and along the Root River in the southwestern quarter of the county. There is also one tract along Oak Creek near South Milwaukee.

The surface soil of the Fox fine sandy loam consists of 8 to 10 inches of dark grayish-brown fine sandy loam. This overlies a yellowish-brown, sticky sandy clay loam. The subsoil becomes more compact at depths of 24 to 36 inches, where layers of gravel and sand are encountered. Some gravel is scattered over the surface.

The surface of the type is level or has a very gentle slope toward the stream along which it occurs. It is all above the flood plain of the streams, and the natural drainage is generally good.

The material forming this soil is of alluvial origin and is found as terraces or as outwash material. The parent material is of glacial origin, chiefly from the underlying limestone. In some places an acid condition has developed in the surface soil, but the subsoil is seldom acid, in fact it frequently contains considerable lime carbonate in the form of limestone gravel or fine earth particles.

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* See page 37 for discussion of chemical composition and improvement of this soil.

This is considered to be a valuable soil. Where the location permits, the trucking industry has been developed, and it is especially well adapted to this type of farming. Where the location is not suitable for trucking, it is devoted to general farming and good yields of the general farm crops are secured. It is easier to handle than the heavy soils of the region.

For general farming this land sells for $150 to $200 an acre. In the gardening section it sells for higher prices.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Fox fine sandy loam:

Mechanical analyses of Fox fine sandy loam.

Description.	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Per cent.	*Per cent*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Soil	1.4	6.1	9.2	32.6	11.1	31.1	8 4
Subsoil	2.0	7.3	9.0	34.5	8.7	26.1	12.0

Chemical Composition and Improvement of Loams and Fine Sandy Loams

The types of soil in this group, while differing somewhat in texture, and in origin, are quite similar in their chemical composition. The Miami loam which is the heaviest of the group has a somewhat larger supply of the mineral plant food elements than the more sandy soils of the group. It has on the average about 900 or 1,000 pounds of phosphorus in the surface 8 inches, about 35,000 pounds of potassium, and about 2,000 pounds of nitrogen. The fine sandy loam soils have about 800 to 900 pounds of phosphorus, from 25,000 to 35,000 pounds of potassium, and about 1,300 pounds of nitrogen.

All of these types are light colored, and are deficient in humus and organic matter. In the improvement of these soils, one of the first steps should be to increase the organic matter content. This can best be done by supplementing the available supply of stable manure with green manuring crops of which legumes are best.

The lime content of these soils was originally high, the coarser particles being made up of limestone. The surface soils have, however, been to a considerable extent leached, so that they are usually acid, even though the subsoil frequently contains the

larger part of its original supply of limestone. Each farmer should, therefore, test for acidity on his own fields, to determine the need of lime, especially for the growth of clover and alfalfa. Where a medium degree of acidity is found from 2 to 3 tons of ground limestone per acre should be applied.

The use of stable manure alone, even though available in liberal amounts, will not maintain the proper balance in the mineral plant food elements in the soil. Manure is comparatively low in its content of phosphorus and potassium. This group of soils is also low in phosphorus, and this deficiency can best be made up by supplementing the stable manure with commercial fertilizers. The phosphorus can be supplied in the form of raw rock phosphate, in which form it is very slowly available, or it may be applied as acid phosphate or in a mixed fertilizer. Where the supply of organic matter and nitrogen are low a mixed fertilizer (2–10–0 or 2–12–0) can be used to advantage for general farm crops. In normal times a small amount of potash may be added. Its addition even under abnormal conditions will usually be profitable, but many hestitate to purchase it at high prices especially when not familiar with its use. Applications of from 200 to 300 pounds of commercial fertilizer per acre are usually made to general farm crops, and this may be applied by a regular fertilizer distributor, by the fertilizer attachment to a corn planter, or through the fertilizer sower attached to a grain drill.

Where trucking is carried on, much larger amounts of the mineral fertilizers can be used with profit than on the general farm crops. From 500 to 1,000 pounds are often used per acre in addition to 10 or 12 tons of stable manure.

It is important to give these types thorough cultivation, though they are not so difficult to handle as the clay loam and silt loam types. The question of selecting the most suitable crop rotations should be given careful consideration, and only such systems followed as will tend to increase the productivity of the soil. Corn one year, followed by a small grain crop one or two years, and then seeding to clover, is a rotation which gives good results. Where the acidity is corrected, and the soil inoculated, alfalfa can be grown, and this crop should be more commonly raised and introduced into the crop rotation.

The question of liming to correct acidity, inoculating for the best growth of legumes, and the rotating of crops both where

general farming and trucking are carried on, should be given careful consideration in order that the fertility of the soil may be gradually increased, and the spread of plant diseases reduced to the minimum.

CHAPTER IV.

GROUP OF POORLY DRAINED AND MISCELLANEOUS SOILS

Clyde Clay Loam

The Clyde clay loam occupies 12.6 per cent of the county or a total of 19,392 acres. This soil occurs in shallow depressions in the upland and as long strips bordering the streams and marshes. Areas varying in size from 3 or 4 acres to a square mile are found in various parts of the county. Of the larger areas, one occurs a mile west of Whitefish Bay, one just west of North Milwaukee, one just west of Cudahy, and another near the southwest corner of the county south of Heelyton.

The Clyde clay loam consists of 12 to 16 inches of a dark gray or black sticky loam to silty clay loam overlying a blue or mottled yellow compact clay loam. In places the mottled subsoil contains some fine sand and gravel below a depth of 30 to 36 inches. The soil is quite uniform throughout its extent, is stone free, very high in its content of organic matter, and from the standpoint of the plant food which it contains it is a very well balanced soil.

The surface is low, level, and naturally very poorly drained. Most of it is so situated that it can be drained by open ditches or tile drains, or by a combination of both. Numerous tracts have been drained and placed under cultivation with excellent results.

This soil is partly of alluvial origin where it occurs along streams, and in part lacustrine. Some of the larger tracts were doubtless at one time old lake beds. The parent material was largely limestone which may have been first acted upon by the ice, and later deposited by running or quiet waters. The high organic matter content is due to the growth and decay of large amounts of vegetable matter under moist conditions. Since much of the earthy material came from limestone, and as the

waters flowing into these low areas carry varying amounts of lime this soil is not acid. The subsoil in particular contains considerable amounts of lime carbonate.

The native growth on this soil consisted of elm, ash, willows, coarse grasses and other water loving plants. Most of the valuable timber has been removed, but because of the poor drainage considerable amounts of this soil are still unimproved.

This soil is being quite rapidly improved by the use of tile drains and open ditches, and where thorough drainage is provided excellent crops are being secured. Near Milwaukee the soil is used for trucking crops with good results. Farther out more of the land is utilized for general farming purposes and such crops as corn, hay, sugar beets, potatoes, and even small grains are grown. The quality of grain, however, is not as good as where grown on light colored upland soils of this region. This is excellent corn land, except for danger of frosts.*

The selling price of this land varies greatly, depending mainly upon location. Some farms sell for $500 to $600 an acre, while much of the type farther from Milwaukee and from good roads can be bought for $100 to $200 an acre.

Clyde Loam

Clyde loam occupies only .7 per cent of Milwaukee County, or a total of 1,152 acres. It occurs in rather small detached areas in all parts of the county, and is closely associated with Clyde clay loam and Peat.

The surface soil of the Clyde loam consists of dark-brown to black fine sandy loam, about 8 to 12 inches deep. The upper subsoil is a grayish-yellow or mottled sandy loam containing considerable gravel. The material below 24 to 30 inches is variable, but is generally a sticky clay or yellowish sandy clay loam. A small area of sandy loam is included with this type. This soil differs from the loam only in texture and in having better drainage. It occurs on the terrace bordering the Milwaukee River west of Whitefish Bay, and is a valuable soil for market gardening.

The surface of this soil is level or nearly so, and the natural drainage is poor. It has a somewhat higher position, however,

* See page 42 for chemical composition and improvement of this soil.

than much of the Clyde clay loam, and is therefore more easily drained. Numerous areas of this class of land have been drained by means of tile or open ditches and placed under cultivation.

The material forming this soil is partly alluvial, and in places probably in part lacustrine. The dark color is due to the growth and decay of vegetation under very moist conditions. The earthy material has come largely from limestone, and as the waters flowing into the low lands carry varying amounts of lime carbonate this soil is not acid.

The native vegetation on this soil consisted of elm, ash, willows, coarse grasses, and other water loving plants.

When thoroughly drained this makes an excellent soil. It is better suited to truck crops than is the clay loam, and as it contains considerable amounts of sand and large amounts of organic matter it is easy to cultivate. The garden crops grown include onions, potatoes, melons, tomatoes, celery, beets, etc. In a number of places general farm crops are also grown. When small grains are grown they are apt to lodge, and the grain is not as well filled, as heavy nor of as good quality as grain grown on the upland soils. It is an excellent corn soil.

Methods of Improvement for Clyde Clay Loam and Clyde Loam

Since these soils are formed along the border line between upland light colored soils and peaty and muck marsh soils, they are intermediate in chemical composition between these two extremes. Moreover, their position is such that they have received a considerable deposition of fine silt from the higher land with its larger content of plant food. These soils have in the surface 8 inches approximately 2,000 pounds of phosphorus per acre; from 30,000 to 40,000 pounds of potassium; and approximately 10,000 pounds of nitrogen. Since they are surrounded by highland, the subsoils of which are rich in ground limestone which is being continuously dissolved and carried to the lower lands by percolating waters, they are as a rule not acid, and in fact usually contain considerable quantities of lime carbonate.

In spite of their large content of both phosphorus and potassium, it is not infrequently true that these soils show low

availability of these elements, especially of potassium. This is probably due to the inert condition of much of the organic matter which protects the earthy part of the soil. Where thoroughly good artificial drainage has been developed and nevertheless poor crops secured, this result will usually be found to be due to lack of available potassium and in some cases also of phosphorus. A direct experiment should be made in these cases with potassium and phosphate fertilizers, as suggested in the bulletins of the Experiment Station.

The most important question in the improvement and management of these soils is one of drainage. Practically all areas are in need of drainage, and tile drains will be found most practical in the majority of cases. When properly drained and well managed, very satisfactory yields can be secured. Cabbage, onions, and sugar beets are some special crops which can be successfully raised on these soils, aside from the general farm crops, such as timothy, alsike, clover, and corn.

Where the location is favorable the trucking industry could be extended on drained areas of these types, especially on the loam, as this is somewhat easier to work than the clay loam.

Waukesha Loam

This type occupies only .7 per cent of the county or a total of amout 1,024 acres. It is confined to the region north of Milwaukee along the Milwaukee River west of Whitefish Bay. Here it is associated with the Waukesha sandy loam.

The Waukesha loam consists of a very dark chocolate-brown to black or grayish-black fine sandy loam to loam, underlain at about 8 to 16 inches by a gray or yellowish sandy loam or sand. In places this sand is iron stained. Occasionally a thin layer of compact sandy clay, 1 inch to 6 inches in thickness, occurs at 18 to 30 inches from the surface. The deep subsoil is sandy or gravelly.

The surface of the type is level or nearly so, though there are a few slight undulations. The natural drainage, especially over the tract just west of the town of Whitefish Bay, is somewhat deficient. Over the remainder of the type the drainage is fair, though a considerable proportion of this soil would be greatly improved by tile drains. In dry seasons the soil can be cultivated readily, but in wet seasons, owing to the flat sur-

face and the accumulation of seepage water from the higher lands adjoining, some parts of the type are too moist for good results with garden crops.

As mapped the Waukesha loam includes a small area of gravelly clay loam. This occupies a high terrace position. The soil consists of 6 to 10 inches of dark-brown to chocolate-brown, heavy gravelly clay loam, containing some coarse sand and overlying reddish chocolate-brown, compact, sticky clay loam. Gravelly sandy clay loam, carrying coarse gravel, occurs at 24 to 36 inches, with layers of coarse gravel and sand in the deep subsoil. Small gravel one-half inch to 2 inches in diameter thickly covers the surface in places. The clay content of the surface soil makes it rather heavy for the best gardening conditions, and it does not dry out as quickly after rains as the more sandy soils about it, so that it is used more extensively for general farm crops than for garden and truck crops, which are produced extensively in this vicinity. Potatoes, corn, rye, oats, clover, alfalfa, and some truck and garden crops are grown. The soil is strong and productive.

The Waukesha loam, with the exception of the gravelly clay areas, is used for trucking, a wide variety of truck crops being grown. Horse manure hauled from the city is applied, but little commercial fertilizer is used.*

The value of this type ranges from $350 to $1,000 an acre, depending mainly upon location, improvements, and value for gardening.

Waukesha Sandy Loam

This soil occupies 1.2 per cent of Milwaukee County, or a total of about 1,856 acres. It occurs along streams as terraces. The largest tract is found along the Milwaukee River in the vicinity of Silver Springs. Other areas occur along the Menominee River west of Milwaukee.

The Waukesha sandy loam consists of 8 to 12 inches of dark-brown sandy loam to fine sandy loam overlying the yellowish-brown sandy loam or sand. The subsoil is variable, containing layers of coase sandy loam with some gravel or fine yellow sand. In some places a sticky coarse sandy clay loam layer, 2 to 6

* For a discussion of methods to improve this soil see page 46.

WAUKESHA SANDY LOAM NORTH OF MILWAUKEE.

The surface features here are representative of the Fox, Waukesha and Plainfield soils. The farms are small and most of them are intensively cultivated.

RAISING CELERY ON PEAT LAND WITHIN THE CITY LIMITS OF MILWAUKEE.

This land was originally a tamarack swamp, which was reclaimed about 45 years ago. For the past 40 years it has been devoted to celery growing almost exclusively. Large amounts of stable manure are used each year.

inches deep, is encountered at 20 to 30 inches. Sand and gravel are present in the deeper subsoil.

The surface is level, and being elevated from 5 to 20 feet above the streams, the natural drainage is good. It is not subject to flooding at any time. In prolonged dry spells crops may suffer to some extent from the lack of sufficient moisture.

The Waukesha sandy loam is a terrace formation and was deposited by stream action during and following the glacial period. The material is largely of glacial limestone origin, though the sandy particles may have come in part from regions where other rocks than limestone occur. The soil is acid in practically all cases, and responds well to the use of lime.

This type occurs along the streams as terraces lying 5 to 20 feet above the stream beds. The larger areas occur along the Milwaukee River in the vicinity of Silver Spring and west of Whitefish Bay. The soil is not extensive. The surface is nearly level. Being usually well elevated above the streams and having a porous, open subsoil, the type has good drainage. In prolonged dry periods crops suffer to some extent for lack of moisture.

Practically all the type is under cultivation. It is used for gardening, for which it has a high value, owing to its location near the city. On the whole this is one of the best trucking and gardening soils; while it has the disadvantage of a somewhat lower organic-matter content and water-holding capacity than some of the other trucking soils, it possesses certain advantages. It is easily worked, can be cultivated very early in the spring and almost immediately after moderate rains, responds quickly to manuring, and is quite easily kept free from weeds.

Practically all this soil is used for the production of garden crops. Two crops and sometimes three of the rapidly growing sorts may be grown on the same plot in a season. Many different vegetables are grown. The truck farms range in size from 3 to 20 acres. Very few of the farmers specialize, but grow a variety of crops. Some of the garden farmers practice a general rotation of field crops, such as corn, clover, potatoes, or grain, with garden or truck crops, while others produce truck crops continuously, varying the succession of crops in their various plots. Stable manure hauled from the city is applied to the land, usually at the rate of about 20 loads per acre.

Commercial fertilizers, while not commonly used, are being tried by an increasing number of farmers, and with good results.

Some of this land sells for $250 to $400 an acre, but much of it on the main roads and lying near Milwaukee is held at $600 to $1,000 an acre.

Methods for the Improvement of Waukesha Loam and Waukesha Sandy Loam

In the improvement of these soils the establishment of thorough drainage is of prime importance. The use of lime to correct the acidity is also advisable, since this will not only make possible the growing of the best legumes, but it will also help to increase the yields of practically all truck crops. The types are somewhat deficient in phosphorus, and the use of acid phosphate or a mixed fertilizer containing this element will be found profitable. Where trucking is carried on a mixed fertilizer containing nitrogen, phosphoric acid and potash can be used with profit. Applications of from 500 to 1,000 pounds per acre are common in many trucking districts. This may be used alone or in addition to 10 to 12 loads of manure per acre.

Peat

Peat consists of dark-brown to black, spongy organic material derived from the partial decay of water-loving vegetation in wet areas. The material is finely divided as a rule and fairly well decomposed. It is 18 inches or more in depth. There are often thin mossy layers in the surface material which are less well decomposed. The subsoil, or bottom, of the undrained areas and marshes is generally a bluish, dense clay or mottled reddish and yellowish clay loam or sandy clay loam. The surface covering of organic material varies in depth. The extent of decomposition and the quantity of mineral matter mixed with it vary somewhat.

In a few cases this material might properly be mapped as Muck, but prevailingly it is well-decomposed, finely divided Peat. It may be slightly or even markedly acid to litmus paper. The only marl deposit encountered is in sec. 18, T. 6 N., north of the Beloit Road and near the Waukesha County line. This deposit is less than one-half acre in extent and consists of rather impure marl.

The Peat occurs in small depressions ranging from about 5 to 80 acres in extent. These areas are widely distributed through the county, and are especially numerous in the southwestern corner southeast of St. Martins. The Peat occurs also along stream courses, as in the area west of Carrollville in the southeastern corner of the county, drained by Oak Creek.

The Peat areas are generally marshy and support an open growth of grass or brush. Occasionally there is a growth of elm, ash, or tamarack trees.

Peat areas in many cases, especially near the city of Milwaukee, have been drained and used for growing truck crops, especially celery. Some of the oldest celery farms on the south side of the city have been used as building sites, and in some cases the growers have started new celery farms farther out. Celery has been grown for 40 years on the same field in some cases. Stable manure is used, as much as 30 to 40 loads per acre often being applied yearly. Onions, cauliflower, potatoes, cabbage, and garden vegetables are also produced and sold at the city markets.

Peat suitable for gardening sells for $75 to $200 an acre, depending upon location and improvement. The tracts whose values are influenced by their proximity to Milwaukee have a much higher selling value.

Peat, shallow phase. In mapping Peat a separation is made on the basis of depth of the peaty material, and a shallow phase is separated. In this phase the clay subsoil is encountered at depths of 3 to 18 inches. In other respects the phase is like the main body of the type, although it often carries more mineral matter—silt, clay, and sand—and the organic material itself may be more thoroughly decomposed.

Methods of Improvement*

Peat has been largely formed by the accumulation of vegetable matter, particularly sphagnum moss and certain sedges and grasses. It is very low in earthy matter, running from 80 to 95 per cent. of organic matter. The amount of the mineral elements is consequently low, the total weight of phosphorus being approximately 600 pounds per acre to a depth of 8 inches,

* Wisconsin Experiment Station, Bulletin 205, Management of Marsh Soils.

and of potassium, 700 pounds. It will be seen, on comparison of these statements with those made on the composition of such soils as Miami clay and silt loams, that the total amount of potassium, in particular, is extremely small, the amount in Peat being often less than 2 per cent. of that found in the upland silt and clay loam soils. While the total amount is small, a large proportion of it is available to plants, especially if the surface has been burnt over, and the supply may be sufficient for from 1 to 3 crops. It is to be expected, therefore, that profitable cropping is possible over a long period of years, only by the use of some form of potassium fertilizer, either barnyard manure, wood ashes, or the usual commercial fertilizers containing this element. The total supply of phosphorus is rather low, though the difference between the amounts present in Peat and upland soils is very much less than in the case of potassium. In view of the enormous quantity of nitrogen contained in these soils, the average amount of which is over 15,000 pounds per acre 8 inches, it is unnecessary to use stable manure, the most valuable element of which is the nitrogen, so that, on farms including both Peat land and upland soils, the stable manure should be used on the upland, and commercial fertilizer containing phosphorus and potash on the lower land, unless, indeed, there is sufficient manure for the entire farm. These marsh soils are rarely acid on account of the percolation of lime-containing water from higher lands, though occasionally patches of acid Peat are found on the larger marshes. This acidity, however, is not so detrimental in the case of marsh lands as in the case of sand and clay soils, since the chief objection to acidity is that it interferes with the growth of those legumes, such as clover and alfalfa, which are needed on the higher lands to secure nitrogen, but which are not needed on the marsh soils for this purpose, and to the growth of which, indeed, the marsh soils are not physically so well adapted.

In the improvement of Peat the question of drainage is the first step to be considered. Both open ditches and tile drains can be utilized in reclaiming the marshy tracts. The major portion of the Peat can be profitably drained and improved. When properly handled the Peat will produce profitable crops of corn, alsike clover, timothy, and a number of other general farm crops, as well as special crops such as peppermint, celery, etc.

While the trucking industry is highly developed on some of the tracts of Peat, there is room for the extension of this type of farming, as rapidly as thorough drainage can be provided. The reduction of the amount of stable manure commonly used and the introduction of the use of mixed fertilizers replacing the manure, or supplementing smaller applications, it is thought, will result in larger yields and more economical production.

Poygan Clay Loam

This type occupies only .2 per cent of the county or about 384 acres. The type occurs in scattered patches and is confined to the northeastern corner of the county where it is associated with the Superior clay loam, rolling phase.

The Poygan clay loam consists of 6 to 14 inches of dark-brown to black, sticky clay loam with a mottled or bluish, tight clay subsoil which often grades into read heavy clay at varying depths below 3 feet. Large quantities of sand and some gravel are sometimes present in the subsoil, the material being a bluish gravelly clay or sandy clay below about 24 or 36 inches.

The narrow strip of this soil bordering Lake Michigan just south of Fox Point consists of a series of fans of clay loam eroded from gullies in the red clay above and deposited over the beach sand along the lake. A part of it is poorly drained, being kept wet by seepage. The type lies 3 to 15 feet above the lake level.

The surface of this type is low, level, and naturally poorly drained. It occupies saucer shaped depressions in the upland or is found bordering water courses. It is so situated that in most cases it can be drained by the use of tile.

The material forming this soil is largely lacustrine. The subsoil is the same as that of Superior clay loam, but to the surface there has been added a large amount of organic matter from the growth and decay of vegetation under moist conditions. This soil is not acid. The subsoil contains a considerable amount of lime carbonate.

While the original timber has nearly all been removed only a small part of this soil has been drained and placed under cultivation. At present its chief use is for hay and pasture. When drained it makes an excellent soil, well adapted to a wide

range of general farm crops, as well as to cabbage, sugar beets, etc.

In the improvement of this soil the first step is that of providing thorough drainage. With this supplied excellent crops can be grown. The type is well supplied with all of the necessary plant food elements.

Plainfield Fine Sand

This is the most limited soil in Milwaukee County, covering only about 64 acres. The Plainfield fine sand, as mapped in this county, includes all the sand areas. It occurs in only a few small bodies. Two areas, one at the mouth of Oak Creek opposite South Milwaukee, and the other just north of Fox Point, consist of deposits of beach sand. They occur as narrow strips of sand lying between the lake and the bluff. No agricultural use is made of these deposits.

Another area includes small knolls or ridges on the terraces west of the Milwaukee River and northwest of Whitefish Bay. The soil consists of yellowish-brown fine sand, and the subsoil is a yellow fine sand. Both soil and subsoil contain some gravel. This soil is used for trucking, to which it seems fairly well adapted, but it requires heavy applications of manure and is subject to drought to some extent in dry periods.

Another small area of fine sand occurs between Bay View and St. Francis. The topography is nearly level. This area is used in part for gardening and in part for general farm crops. The soil is badly run down and in need of improvement.

CHAPTER V.

GENERAL AGRICULTURE OF MILWAUKEE COUNTY

The type of agriculture in Milwaukee County from about 1830 to 1850 was general farming. Land was cheap, the population was scattered, and the prices received for farm products were much lower than at present. Grain, hay, and livestock were the chief products. By 1860 wheat, oats, and corn had become the important crops. The first cargo of wheat is said to have been shipped from Milwaukee in 1841. With the increase in population in the county, both urban and rural, the demand for garden products became greater, the price of land advanced rapidly, and the number of farms increased, with a decrease in the average size. Owing to low prices and decreased yields, wheat production steadily declined after about 1870, while the production of market-garden and orchard crops increased. Small market gardens and truck farms in recent years have taken the place of the larger dairy and general farms near the city of Milwaukee. There has also been an increase in the number of tenant farms.

At the present time, aside from trucking and market gardening, the agriculture of the county consists of combined general farming and dairying. Special crops, such as cabbage, sugar beets, or potatoes, are grown by many farmers, but a majority depend mainly upon the products of the dairy, and most of their crops are produced for feeding live stock.

There are only three creameries in operation in the county, two of which are in Milwaukee, and most of the milk and cream is hauled or shipped to this city and a large part of it is consumed as fresh milk. Many farmers sell whole milk, others separate the cream and sell it or make butter, which is sold in the city. The advantage of the latter method is that the young calves can be raised on the farm, while with the former the calves must generally be disposed of and cows bought to maintain the

herd. Small quantities of hay and grain and small numbers of calves and hogs are sold by these farmers.

The following table, compiled from the 1910 census, gives the number of live stock in the county and the sales of farm animals, by classes:

Number of domestic animals sold or slaughtered and number on farms

Domestic animals on farms:		Domestic animals sold or slaughtered:	
Milch cows	11,131	Calves, sold or slaughtered	6,093
All other cattle	3,633	Other cattle, sold or slaughtered	3,810
Horses	6,679	Horses and mules sold	188
Hogs	7,241	Swine, sold or slaughtered	7,461
Sheep	367	Sheep and goats, sold or slaughtered	80

From the reports of assessors for 1917 it is found that the number of cows was practically the same as in 1909. The total number of all cattle, and the number of hogs, and sheep also remained about the same.

In the 1910 census oats is reported as the leading grain crop, with a production of 548,110 bushels from 15,368 acres. Corn is reported on 10,015 acres, with a production of 397,882 bushels; barley on 3,668 acres, with a production of 112,089 bushels; and rye on 1,234 acres, with a production of 24,448 bushels. Wheat is reported on somewhat less than 500 acres, producing about 10,000 bushels. Tame and cultivated grasses are reported on 28,808 acres, producing 43,531 tons of hay, and about 4,500 acres are reported in wild grasses and forage crops, with a production of about 12,000 tons. Potatoes occupied 6,905 acres, with a production of 803,595 bushels, and all other vegetables a total of 4,400 acres. There were 571 acres devoted to sugar beets, producing 6,948 tons. A total of 77,799 apple trees and about 3,000 grapevines are reported in the county. Strawberries are grown on about 100 acres.

In the following table a comparison is made of the acreage devoted to general farm crops in 1909, and in 1917.

Crop	1909 (Census) Acres	1917 (Assessors) Acres	Yield per acre 1917
Oats	15,368	16,000	46
Corn	10,015	11,000	
Corn, % cut for silo		69%	
Winter wheat	205	275	21
Spring wheat	239	1,200	20
Barley	3,668	2,800	30
Rye	1,234	1,000	21
Buckwheat	18	15	20
Clover and timothy	27,474	25,500	1.4T
Wild hay	3,378	3,500	1.4T
Alfalfa	383	530	2.1
Cabbage		1,335	6 T
Potatoes	6,905	6,800	92 Bu.

It will be noted that in most cases the acreage of the various crops has remained about the same. The greatest increase in proportion to the total acreage has been in spring wheat. This was due largely to the greatly increased demand for wheat owing to the war.

The following table gives the value of the various farm products, as reported in the 1910 census:

Value of farm products, arranged by classes

Product	Value	Product	Value
	Dollars	Live stock and products:	*Dollars*
Cereals	588,502	Animals sold and slaughtered	346,498
Other grains and seeds	19,442	Dairy products, excluding home use	675,178
Hay and forage	642,359	Poultry and eggs	188,447
Vegetables	853,902	Wool, mohair, and goat hair	340
Fruits and nuts	67,397	Total value	3,740,293
All other crops	358,228		

While the acreage of most of the general farm crops has remained about the same since 1909, the value of all farm produce has greatly increased. In many cases it has more than doubled.

The garden crops are of many different kinds. Among the most important products are celery, berries, lettuce, radishes, onions, melons, sweet corn, asparagus, tomatoes, cabbage, cauliflower, cucumbers, and peppers. With the improvement of the roads, gardening is spreading to cheaper and more favorable soils and into areas 15 to 20 miles distant from Milwaukee. The products are hauled by team or motor and sold at the public markets, to wholesale produce dealers and commission merchants, or peddled to regular customers in the city. The interurban railways run express cars which carry milk and garden produce to the city. From Hales Corners the cost is 20 cents per hundred pounds, and crates, cans, etc., are returned free to the owner's nearest station. Records in Milwaukee show that in the months of May, June, July, August, September, and October, 1916, a total of 18,357 loads of products was delivered to the public markets. The estimated value of each load is $35.

A general recognition of the adaptation of the various soils to certain crops is represented by the local grouping of the soils into three classes—celery land, garden soil, and clay soil. The drained Peat is the soil referred to as celery land, the sandy terrace soils and the dark-colored soils as garden soil, and the general upland clay and silty clay loam, which are used for dairying and general farming, as clay soils.

With the exception of trucking and market gardening, the most specialized agriculture is the production of celery, sugar beets, and cabbage. The sugar beets and cabbage are generally grown on the larger dairy farms as cash crops, while celery growing is a separate industry. The young celery plants are grown in beds under glass, transplanted by hand to shallow trenches made in the Peat field, and the rows gradually hilled or ridged up as the plants develop. The young cabbage plants are grown in open beds and transplanted in rows, generally with the aid of a planter, and are merely hoed and cultivated until mature. Fifteen to twenty-five tons of cabbage per acre is considered a good yield. Sugar beets are often grown in cooperation with a beet-sugar company, the nearest one being at Menominee Falls in Waukesha County. Under a labor contract the seed and all hand work, such as hoeing, weeding, thinning, topping, and loading, are provided by the sugar company for $21 per acre, while the farmer does all team work, such as plowing, seeding, cultivating, and hauling to the ship-

ping point. Fifteen to twenty tons per acre is considered a good yield.

Most of the farms in the county have good houses, barns, and other buildings, and these are well cared for. In general, the best improvements are found in the northern half of the county. Silos are in general use in all parts of the county. On most of the general farms from 3 to 5 horses and 5 to 30 head of other stock are kept.

A number of farms have buildings somewhat resembling silos, but not so high and of greater diameter, for the storage of dry distillers' or brewers' grains. This product is used quite extensively, especially in the southern half of the county, as a supplementary feed for cattle and hogs. Most farmers haul the grains in a wet condition direct from the brewery or distillery in a large, tight box or a large barrel, of a capacity four or five times that of an ordinary barrel, and mounted on wheels. From 85 cents to $3.20 per load is paid for this wet grain mash, depending upon the size of the container. This material is fed to the stock in a wet condition. The dry brewer's grain which is frequently stored by the farmers as above indicated, is considerable higher in price.

A common rotation on the dairy and general farms consists of hay 2 years, corn 1 year, and grain 1 year, with perhaps another cultivated crop 1 year. Where alfalfa is grown—and this crop is being gradually introduced—such a rotation is necessarily altered or abandoned, as alfalfa occupies the land for several years. Alfalfa is not not grown generally or in large quantities, although it is said that little trouble is experienced in getting a good stand.

The trucking industry in Milwaukee County has reached considerable proportions. As concrete roads are being extended so that the automobile can be more economically used, the area throughout which truck crops can be successfully grown and easily marketed is also rapidly extending.

In the development of the trucking industry there are several factors which should be kept clearly in mind. The rotation of crops where trucking is carried on is just as important, or even more so, than where general farming is practiced. At intervals it is wise to plow under a legume crop. This practice, together with the other changes from year to year in the crops grown will greatly check and tend to prevent the spread of

plant diseases. In most cases large amounts of stable manure from Milwaukee are used. This practice brings to the farm many weed seeds. Where a green crop is plowed under, this reduces the need for so much manure.

The supply of stable manure, even when the city supply is considered, is not sufficient to meet the fertilizer needs of the soils of the county. It is therefore necessary to supplement the manure with other sources of plant food. The green manuring crops make up one source which should be more commonly drawn upon. This fertilizer is produced at home and its use greatly reduces the danger from the introduction of weed seeds.

But neither stable manure nor green manuring crops fully meet the needs of the crops which are usually grown. These fertilizing materials as well as most of the soils of the county are deficient in their phosphorus supply, and before maximum crop yields can be secured most economically it is necessary to provide this element. Acid phosphate is the form in which it is most readily available. This may be used on general farm crops at the rate of 200 to 300 pounds per acre, or to trucking crops up to 1,200 or even more pounds per acre. It may be applied along with the stable manure as a top dressing, or it may be sown with a fertilizer attachment to a grain drill at the time of seeding a small grain. On some truck crops small applications are sometimes made at intervals during the period of growth. Where the amount of manure is limited and green crops are not plowed under the use of a complete fertilizer will be found profitable, especially where trucking is carried on.

In Milwaukee County the use of commercial fetilizers is not common, but the amount being used is gradually increasing. In general farming and trucking more consideration is being given this question each year, and quite a number are now making fertilizer trials in a small way. Where properly applied, and where the right kinds are used, very gratifying results are being obtained.

It is difficult to obtain farm labor, and the cost is rapidly increasing. As much as $50–$75 a month with board is sometimes paid for good farm hands. Much of the gardening and the celery and sugar-beet handwork is done by women, girls, and boys, usually members of the farmer's family.

The 1910 census reports a total of 2,443 farms in the county, averaging 47 acres in size. About 77 per cent of the area of

the county is in farms, and of the farm land about 85 per cent, or 40 acres per farm, is reported improved.

Somewhat over one-third of the farms in the county are operated by tenants. The rent varies from $8 to $30 an acre, depending upon the location of the land and the kind of farming practiced. The higher price is paid for the garden land.

Land varies widely in value, ranging from $100 or $125 in the remote parts of the county to $300, $400, and even $1,000 an acre for garden and celery land near the city.

CHAPTER VI.

CLIMATE

The climatic conditions prevailing in Milwaukee County are characteristic of a considerable region in eastern and southeastern Wisconsin immediately bordering Lake Michigan. The mean annual precipitation as reported by the Milwaukee station is 31.40 inches; the total rainfall for the driest year as given by the Weather Bureau is 18.69 inches, while the total for the wettest year is 50.36 inches.

This rainfall is, as a rule, fairly well distributed throughout the year, and especially during the growing season when it is most needed. Frequently, however, there are years when periods of dry weather alternate with periods of unusually heavy rainfall. These may continue from one to four weeks and occasionally longer. Observations made by the weather bureau station at Madison, where the rainfall conditions are very similar, covering a period of 30 years from 1882 to 1911, show that there are on the average three 10-day periods in each growing season in which the rainfall is so light that crops on a reasonably heavy soil suffer from lack of moisture.

The average date for the last killing frost in the spring in Milwaukee County is given by the records as April 27, and the average date of the first killing frost in the fall is given as October 10. This gives a growing season for Milwaukee County of approximately 166 days. The date of the latest killing frost recorded for the spring in Milwaukee County is May 29, and the date of the earliest killing frost in the fall is given as September 25.

The influence of Lake Michigan is quite marked in this county. The large body of water has the effect of delaying the opening of spring, but when warm weather finally begins it has a tendency to keep climatic conditions more uniform than in sections remote from large bodies of water, so that in this region summer frosts and early fall frosts are very rare. While the num-

ber of days between killing frosts is 166, as given, there is a considerable period after the last killing frost in the spring and before good growing weather begins during which the temperature is relatively low, and when such crops as corn will make but little progress. The land immediately bordering the lake and for some 5 or 10 miles back is for this reason not so well adapted to corn as land lying in the same latitude but farther inland. The influence of the lake accounts for more cool nights than are found in the interior of the State, and this of course is not conducive to the rapid growth of corn.

The mean annual temperature of the Milwaukee station is 45.3° F. The highest temperature recorded is 100°, and the lowest —25°.

The following table is compiled from the records of the Weather Bureau station at Milwaukee:

Normal monthly, seasonal, and annual temperature and precipitation at Milwaukee.

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1901)	Total amount for the wettest year (1876)
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	27.0	63	—22	1.92	1.69	2.16
January	19.8	61	—25	2.01	1.33	4.39
February	21.9	60	—24	1.89	1.92	3.63
Winter	22.6	63	—25	5.82	4.94	10.18
March	30.9	81	— 8	2.67	3.62	5.29
April	41.8	86	12	2.70	.47	2.83
May	53.6	94	25	3.42	1.75	8.54
Spring	42.1	94	— 8	8.79	5.84	16.66
June	63.5	98	38	3.67	1.12	4.76
July	69.7	100	47	3.01	2.03	4.39
August	68.7	98	42	2.82	1.50	5.52
Summer	67.3	100	38	9.50	4.65	14.67
September	61.5	96	25	2.92	1.86	3.66
October	50.2	88	15	2.39	.65	1.62
November	36.1	73	—14	1.98	.75	3.57
Fall	49.3	96	—14	7.29	3.26	8.85
Year	45.3	100	—25	31.40	18.69	50.36

subsoil. The series is divided into phases on the basis of topography, and the level phase is considered to be typical. The heavy subsoil makes the level phase somewhat deficient in drainage, and thus rather cold and backward in the spring. The rolling phase has good natural drainage, and is the more desirable soil. The Superior clay loam, rolling phase, and the Superior fine sandy loam were mapped in Milwaukee County.

The Poygan series is represented by only one type, the clay loam. It is of small extent and is relatively unimportant.

The Fox series is represented by two members, the fine sandy loam and silt loam. It includes light-colored terrace soils. These are productive and valuable soils, but are not extensive in this county.

The Waukesha series includes the dark-colored well-drained limestone soils laid down by water as outwash areas or terraces and having stratified gravelly or sandy subsoils. In this county it includes two types, the sandy loam and loam. These soils are used for market gardening.

The Plainfield series is represented by a single type, the fine sand. This type is made to include all the sand areas mapped in the county.

Peat consists of an accumulation of decaying vegetable material overlying clay. Some of the Peat land has been drained and is used for celery culture, gardening, and general farming.

The agriculture of the county consists of general farming and dairying, trucking, and market gardening. The general crops, oats, barley, corn, hay, and alfalfa, are produced on the dairy farms. Special crops, such as sugar beets, cabbage, potatoes, celery, and onions, are grown on the truck farms and smaller dairy farms, and vegetables of all kinds are grown in the market gardens, located mainly in the vicinity of Milwaukee.

The farms, particularly in the northern part of the county, are well improved. In general, farming is in a prosperous condition and the average price for farm land in the county is well above the average price per acre for the State. The adaptation of the soil to certain crops is generally recognized, and some attention is given to crop rotation. Manure is commonly applied to cultivated land, but little commercial fertilizer is used.

According to the 1910 census, there is a total of 2,443 farms in the county, averaging 47 acres in size. About 77 per cent of the area of the county is in farms, and of the farm land about

85 per cent, or 40 acres per farm, is reported improved. Somewhat over one-third of the farms are operated by tenants. The average value of farm land is reported as $197.49 an acre.

The growing season averages 166 days. The mean annual temperature is 45.3° F., and the mean annual rainfall 31.40 inches.

KEEP THE MAP

The Experiment Station will publish bulletins from time to time dealing with the management of the different types of soil mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

W. O. HOTCHKISS, Director and State Geologist
A. R. WHITSON, In Charge, Division of Soils

SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
H. L. RUSSELL, Dean

BULLETIN NO. 56B SOIL SERIES NO. 29

SOIL SURVEY

OF

RACINE AND KENOSHA COUNTIES

WISCONSIN

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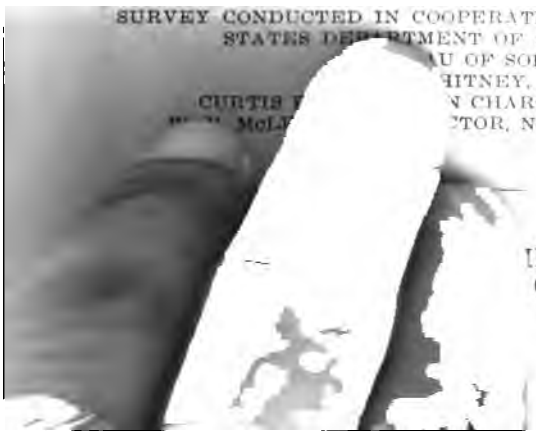

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INTRODUCTION

Before the greatest success in agriculture can be reached, it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in coöperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the state, and to be of practical help to farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: First, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity and other physical properties of soil all depend chiefly upon *texture*, which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere. Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis*, which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

The textural classification is the most important since it has to do with the water holding capacity of the soil. It also determines the ease with which a soil can be worked, and has much to do with the crops to which the soil is best adapted.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.
Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.
Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Very fine sand.—Over 50% very fine sand.

Soils Containing Between 20–50% of Silt and Clay

Sandy loam.—Over 25% fine gravel, coarse and medium sand.
Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Sandy clay. Less than 20% silt.

Soils Containing over 50% of Silt and Clay

Loam.—Less than 20% clay, and less than 50% silt.
Silt loam.—Less than 20% clay, and over 50% silt.
Clay loam.—Between 20 and 30% clay, and less than 50% silt.
Silty clay loam.—Between 20 and 30% clay, and over 50% silt.
Clay.—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a gradation in texture of otherwise uniform material, such a group is called a *soil series.* It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for example, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, where the parent rock was largely sandstone, and where the material occurs as outwash plains or stream terraces. The soils in this series also have a wide range in texture. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey. By uniting the soil class and the soil series we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF RACINE AND KENOSHA COUNTIES, WISCONSIN

CHAPTER I

DESCRIPTION OF THE AREA

Racine and Kenosha counties are located in the southeastern corner of the state with Lake Michigan forming the eastern boundary, and the state of Illinois the southern boundary. The total area is about 606 square miles or approximately 387,840 acres.

FIG. 1.—Sketch map showing progress of soil survey. Cross lined counties in north half of state have been covered by a prelimnary survey while ruled counties in south half have been covered by detailed survey of the soils.

The surface features of the region fall naturally into several divisions, each of which is fairly distinct. Beginning along the Lake Michigan shore the first feature of interest is the narrow belt of bench or terrace land which extends back from the lake for from nearly a mile to several miles, and runs parallel with the lake across both counties. The lake has an elevation of 581 feet above sea level and the terrace at Kenosha is 612 feet and

at Racine 629 feet in elevation. The surface is level or very nearly so. The western border is marked in a number of places by a more or less continuous low ridge of gravelly sandy material which represents an old beach line and marks the shore line of the lake when the water stood at a much higher level than at present.

West of the lake terrace is an extensive belt of gently undulating country where the soils are for the most part very heavy and where the surface consists of a series of very broad, low, flat, ridges, or swells. The slope is so gentle that because of the heavy soils the natural drainage is somewhat deficient in places. The region is somewhat higher than the terrace, the town of Union Grove being 780 feet and the town of Bristol being 782 feet above sea level. The belt is from 14 to 20 miles wide and its western border terminates in a line just west of Wind Lake in Racine county and just east of Paddock's Lake in Kenosha county.

The extreme western end of the two counties, including nearly a fourth of the total area is a belt of gently rolling to hilly country which presents a marked contrast to the other two regions just described. It consists of country having an uneven surface which ranges from gently rolling to rough, bumpy, broken and hilly, and contains a great variety of soils. Most of the lakes of the area are found in this belt. It is known to geologists as a recessional moraine of the Late Wisconsin Ice Sheet, and is a part of the Valpariso Moraine.

Within this belt and also along the western border of the two counties there are a number of water laid or alluvial deposits where the surface of the land is level. These are usually found bordering streams or lakes. The total area of such tracts is small but the areas are distinct and readily recognized by their flat surfaces.

In addition to these various divisions there are scattered throughout the region, numerous areas of low lying land where there has been an accumulation of organic matter, in many places sufficient to be classed as peat. Associated with the peat and usually bordering the drainage ways there are also rather numerous areas of heavy, black soils, which are poorly drained, where there is also a large accumulation of organic matter but not sufficient to be classed as muck or peat.

The area surveyed has two drainage systems. The first includes that part of Kenosha county, except a small area along the Illinois line, lying east of the Chicago, Milwaukee and St. Paul Railroad, and almost all of Racine county lying east of Dover and Norway townships, with the exception of a small area near Sylvania. It is drained into Lake Michigan by the Root and Pike Rivers and their tributaries, and also by a number of short intermittent streams, which have their heads along the eastern slope of the most easterly ridges of the region bordering the lake terrace.

The second system is drained by the Desplaines River and the Fox River into the Illinois River. The Desplaines and Fox are separated by a divide extending from east of Cross Lake north through Salem and Klondike to the north central part of Brighton township. The large number of lakes, swamps, and marshes in this region indicate a very young topography, so young that practically all of the lowland has very poor drainage or no drainage at all. The streams have not had time to develop valleys sufficiently deep to ramify all sections with their tributaries to provide drainage for those low areas.

Racine county was formed in 1836, and Kenosha county was set off from it in 1850. The early settlers were of Anglo-Saxon descent, and came largely from New York and New England. Later there was a great influx of Germans, Norwegians, Irish, Scotch and English. All parts of the area are now thickly settled and well developed. The population of the two counties is given in the 1920 census as 130,245, of which 27,554 is classed as rural, averaging 45.0 persons to the square mile.

The city of Kenosha on Lake Michigan in the east central part of Kenosha county is the county seat of Kenosha county, and according to the census of 1920, it has a population of about 40,472. Kenosha is a manufacturing center of considerable importance and is provided with both steam and electric railroad and water transportation facilities to Chicago and Milwaukee. Other towns and shipping points in Kenosha county are Somers, Truesdell, Bristol, Salem, Silver Lake, Wheatland, Trevor, Bassetts and Twin Lakes.

Racine is the county seat of Racine county. It is one of the leading manufacturing cities of the state, and has splendid steam, electric and water transportation facilities. Its population at the last census was 58,953. Burlington, with a popula-

tion of 3,626, is located in the extreme west-central part of this county. It supports condensary, canning factory, sauerkraut factory, blanket factory, and basket factory. It is on two steam railroads, and has one electric road running to Milwaukee. Union Grove has sauerkraut and hemp factories, Franksville has a sauerkraut factory. At Rochester there is the County Agricultural School. Other towns in Racine county include Waterford, Wind Lake, Corliss, Sylvania, Kansasville, Dover and Honey Creek.

The area as a whole is very well provided with rail and water transportation facilities.

The area is provided with a very good road system. A number of concrete roads extend out from Racine and Kenosha, and all of the more important roads are kept in good condition. Under the present road making system all of the public roads receive some attention. For a time during the spring and fall many of the cross and secondary roads are not in good condition. Practically all parts of the area are reached by rural mail delivery routes and by telephone lines.

Racine and Kenosha are the principal home markets and Milwaukee and Chicago are the leading markets outside of the area.

SOILS

Kenosha and Racine counties in common with most of southeastern Wisconsin owe the general character of their surface material to several distinct methods of accumulation. These materials may be glacial, lacustrine (lake deposited) and alluvial. To these important agencies may be added the accumulation of organic matter in low places under poor drainage which has resulted in the formation of peat.

This area was covered by one or more ice sheets during the glacial period. At that time snow and ice accumulated in the region of Labrador and to the west of Hudson Bay to such an amount that it pushed outward from these centers, especially southward, until a point was reached where the ice melted as rapidly as it advanced. In moving across the country, the ice gathered up all sorts and sizes of material, including clay, silt, sand, gravel, boulders, and even large masses of rock. Many of these materials were carried for hundreds of miles and rubbed against surface rocks or against each other until ground

into sand and silt. When, through the melting of the ice, the limit of advance was reached, this transported material accumulated in a terminal moraine, a broad undulating ridge, usually with a steep outer slope and with the inner slope longer and more gradual. The width of these moraines varies from a half mile to three or four miles. When the ice melted away more rapidly than the glacier advanced, the terminus of the glacier would recede and leave this material deposited somewhat uniformly over the area previously covered by the ice sheet. The glacier advanced and receded a number of times, and with each advance another moraine was formed. The intervening tracts are now occupied chiefly by level, undulating, or slightly rolling plains.

The material transported by the glacier varied with the character of the rocks over which it passed. Granites, limestones and sandstones were mixed and ground up together. This mixture of all kinds of material-boulders, clay, sand, silt and gravel is called boulder clay, till, glacial drift or simply drift. The grinding action and denuding power of glaciers is enormous. A mass of ice 100 feet thick exerts a pressure of forty pounds per square inch and this ice sheet may have been several thousand feet in thickness. The material carried along in this mass of ice, especially the boulders and pebbles, became powerful agencies for grinding and wearing away the surface over which the ice passed. Pre-glacial ridges and hills were rubbed down, valleys were filled in with the debris and the surface features were changed entirely.

Since first deposited these various materials have undergone changes due to the action of water, wind, freezing and thawing, and the accumulation of various amounts of organic matter. In the work of the soil survey this material has been classified according to its texture, color, structure, origin, organic matter content, topography, etc., into various groups known as soil series and soil types. Within the present survey 8 series and 24 types were recognized and mapped. Differences with some agricultural significance but not important enough to designate as types are recognized as phases of the types to which they are most closely related.

The Miami series is characterized by light brown to brown surface soils, and yellowish-brown to slightly reddish brown heavier subsoils, resting at depths of 18 to 36 inches, upon a

porous mass of stony and gravelly till, considerably weathered but carrying a high percentage of limestone material. In this series the surface soils are seldom in an acid condition and often do not require applications of lime for maximum crop development. The areas are frequently rolling to irregular, ridgy and bumpy in topography and the natural drainage is good to excessive. Soils of this series have developed under forest cover. They form the dominant soils of the irregular morainic uplands in the western end of the area. Three types are mapped, the silt loam, fine sandy loam and loam.

Soils mapped as a phase of the Miami series are brownish-gray to light brown with a grayish tinge. The subsoil is heavier than the soils in texture, compact and rather tough in structure, yellowish brown in the lighter textured areas where drainage is best to dull yellowish-brown mottled slightly with gray and brown in the areas of heavy texture. A moderately friable to heavy compact, calcareous till, only slightly weathered, forms the substratum at depths of 2 to 3 feet, or in some places at a slightly greater depth than 3 feet. The surface soils are usually in an acid condition and respond favorably to application of lime. These deep Miami soils have developed under conditions of fair to good drainage in forested areas, usually of ground moraine, where the till does not carry excessive quantities of gravel and stone. The silt loam, deep phase, and clay loam members are mapped.

The Carrington series includes types with very dark brown to black soils and a heavier textured, compact, yellowish-brown subsoil that rests upon partly weather calcareous till at depths of 2½ to 3 feet. The silt loam and clay loam members of the series are mapped. There are a few scattering areas of the loam and fine sandy loam of mapable size but these are included with the silt loam on account of their small total extent. These soils developed under prairie conditions.

The soils in the Clyde series are black and the subsoil is gray, mottled with yellow and brown, heavier than the soils in texture, and compact to tough and somewhat plastic. Below depths of 2 to 3 feet the subsoil becomes calcareous and gives way gradually to calcareous till having the same general character as that underlying the Carrington and Miami soils.

With the Clyde series as correlated in this report are the Maumee series and the Newton series as previously mapped by the U. S. Bureau of Soils. The material classed as Maumee series is similar to the Clyde, except that it is waterlaid and is underlain at from 30 inches to 4 feet by lighter material. Its natural drainage is poor. The Newton series recognized by the Bureau of Soils is also similar to the Clyde but it occurs as part of the old Lake Michigan terraces, and is also similar to the Waukesha, except that it is more poorly drained. In the Clyde series, as it appears in this report we have the types, Clyde clay loam, silt loam and fine sandy loam.

The types included in the Rodman series are characterized by brown soil overlying at shallow depths porous beds of stratified gravel and sand carrying a high percentage of limestone material. In many places the surface soils are quite gravelly and give way to beds of gravel without any intervening subsoil layer. The topography is very broken, consisting of kames, eskers and terrace escarpments and the drainage is excessive. The gravelly loam is the only type mapped.

In the Fox series the surface soils are brown and the subsoil is yellowish brown to slightly reddish brown, heavier than the soil, and compact to rather tough in character. The subsoil gives way at depths of 2 to 3 feet, or in some places at greater depth, to stratified beds of gravel and sand in which there is a high percentage of limestone material. The surface soil is neutral to only slightly acid, except in some of the areas in the heavy subsoil phase of the silt loam, where, the stage of soil development corresponding closely to that of the Miami series of the uplands, the acid condition of the soil is more pronounced. The topography is flat to slightly undulating and there are also included some long narrow gravelly low ridges representing beach lines. The natural drainage is good. The series is represented by the loam, silt loam and gravelly loam.

The types of the Plainfield series have light brown soils and a brownish-yellow subsoil, as light as the soil in texture. The substrata are similar in texture to the subsoil or may be lighter in the upper layers and heavier at greater depths. The surface is level to undulating and the natural drainage is good. The series has been formed from material of a noncalcareous character laid down by water and probably modified subsequently to

some extent by wind action. The fine sand occurs in small areas on the Lake Michigan Terrace.

The Superior series consists of types with brown to yellowish-brown surface soils, underlain by a mottled yellow and gray upper subsoil and pinkish-red heavy clay lower subsoil. The heavy underlying clays are moderately calcareous, but the surface soils are in an acid condition. This series occurs in lake terraces occupying flat areas with poor drainage. The types mapped are the fine sandy loam and clay loam with small areas of the loam included as a heavy phase of the fine sandy loam.

The surface soil of the types included in the Waukesha series are very dark brown and the subsoil is yellowish-brown, somewhat heavier and more compact than the soil, and underlain at depth of 2 to 3 feet, or in the deep subsoil phases of the types at greater depths, by stratified beds of gravel and sand carrying a high percentage of limestone material. The surface soils have been leached of excess lime and usually give an acid reaction. The areas are level to slightly undulating in topography and have good natural drainage. Like the Carrington soils, the Waukesha soils have developed under prairie conditions. Four types are represented, the loam, silt loam, with a deep phase, fine sandy loam, and fine sand.

The Genesee soils are not typically developed in Kenosha and Racine counties. As mapped, the surface soils are brownish gray to brown and the subsoil is yellow and gray mottled to light brown. There is no important textural change from the surface downward. These soils are developed in the flood plains of the Fox River and other larger streams of the area where considerable deposition of material still takes place during overflows. The loam is mapped and small areas of the fine sandy loam, too small in extent to show as a separate type, are included as a sandy phase.

Peat and a shallow phase of the peat were mapped. The peat consists of decayed vegetable matter in varying stages of decomposition with which there has been mixed small amounts of mineral matter. In some places of small extent this has been sufficient to make a muck soil.

The names of the different soils with their actual and relative extent are given in the following table:

AREAS OF DIFFERENT SOILS *

Soil	Acres	Per cent
Carrington clay loam	112,320	29.0
Miami clay loam	56,384	14.5
Clyde clay loam	40,128	10.3
Miami silt loam—deep phase	31,808	8.2
Clyde silt loam	34,688	9.0
Peat	23,552	6.5
Shallow phase	1,664	
Fox silt loam	15,616	4.0
Miami silt loam	15,488	4.0
Carrington silt loam	9,920	2.5
Rodman gravelly loam	8,512	2.2
Miami loam	6,272	1.7
Gravelly phase	320	
Waukesha silt loam	3,840	1.4
Deep phase	1,600	
Fox loam	4,608	1.2
Waukesha loam	3,648	.9
Waukesha fine sand	2,908	.8
Waukesha fine sandy loam	3,264	.8
Miami fine sandy loam	3,200	.8
Clyde fine sandy loam	2,368	.6
Plainfield fine sand	1,984	.5
Superior fine sandy loam	960	.3
Muck	832	.2
Fox gravelly loam	832	.2
Dunesand	384	.1
Genesee loam	320	.1
Superior clay loam	320	.1
Total	387,840	.....

*In comparing this report with the soil survey report of the same area published by the U. S. Bureau of Soils, it will be noted that there are differences in the soil type names. Some of the names are different and there are more types described by the Bureau of Soils than are described and shown on the map in this report.

The reason for this difference is that because of the small extent of some of the soil types as described by the Bureau of Soils, and because of the similarity of some soils to others, some combinations and correlations have been made in the state edition for the purpose of reducing the number of types and simplifying the map and report.

The following table gives the names of the various soil types which were recognized and mapped in the soil survey of the Racine-Kenosha area.

Soil Type Names Used in the Report Issued by The Wisconsin Geological and Natural History Survey	Soil Type Names Used in the Report Issued by the U. S. Bureau of Soils
GROUP OF HEAVY SOILS	
Carrington clay loam	Carrington silty clay loam
Carrington silt loam	Carrington silt loam
Waukesha silt loam	Waukesha silt loam
	Waukesha silt loam, deep phase
Fox silt loam	Fox silt loam
	Fox silt loam, heavy subsoil phase
	Fox silt loam, gray sandy phase
Miami clay loam	Miami silty clay loam
Miami silt loam	Bellefontaine silt loam
Miami silt loam, deep phase	Miami silt loam
Superior clay loam	Superior silty clay loam

GROUP OF LOAMS AND FINE SANDY LOAMS

Miami loam	Bellefontaine loam
	Bellefontaine loam, gravelly phase
Miami fine sandy loam	Bellefontaine fine sandy loam
Fox loam	Fox loam
Waukesha loam	Waukesha loam
	Newton loam
Waukesha fine sandy loam	Waukesha fine sandy loam
Superior fine sandy loam	Superior fine sandy loam
	Superior fine sandy loam, heavy phase

GROUP OF SANDY AND GRAVELLY SOILS

Fox gravelly loam	Belmore gravelly fine sandy loam
Rodman gravelly loam	Rodman gravelly loam
Waukesha fine sand	Waukesha fine sand
	Newton loamy fine sand
	Newton loamy fine sand, heavy phase
Plainfield fine sand	Plainfield fine sand
Dunesand	Dunesand

GROUP OF POORLY DRAINED SOILS

Clyde clay loam	Clyde silty clay loam
	Clyde silty clay loam, marsh phase
	Maumee silt clay loam
	Newton clay loam
Clyde silt loam	Clyde silt loam
	Clyde silt loam, marsh phase
	Maumee silt loam
	Maumee silt loam, marsh phase
	Newton silt loam
Clyde fine sandy loam	Maumee fine, sandy loam
	Clyde silt loam, sandy phase
Genesee loam	Genesee silt loam
	Genesee silt loam, sandy phase
Peat	Peat
Peat, shallow phase	Peat, shallow phase
Muck	Muck

CHAPTER II

GROUP OF HEAVY SOILS

CARRINGTON CLAY LOAM

Extent and distribution.—The Carrington clay loam is the most extensively developed soil of the area, covering 112,320 acres. It is the predominating soil in all townships except those bordering Lake Michigan and those bordering Walworth county.

Description.—The surface soil of the Carrington clay loam consists of 12 inches of dark brown to almost black heavy silt loam, or clay loam containing a large quantity of organic matter. The upper subsoil is a brown silty clay loam grading into a brownish-yellow plastic clay which is slightly mottled with yellow and gray. At a depth of about 2 feet the material is a heavy plastic pale yellowish gray clay, interspersed with white splotches of calcium carbonate. At this depth there is a strong reaction with hydrochloric acid, but both Truog and litmus tests indicate that the surface soil is usually acid.

As mapped, this type is subject to some variation. On steep slopes and narrow ridges, where there has been wash, the surface soil is a clay loam of a rather stiff and plastic structure. Along the lower parts of slopes, where there has been an accumulation of washed material, the dark brown silt loam layer may extend to a depth of 18 inches. Where the Carrington clay loam is associated with the Carrington silt loam or the Miami silt loam, as is often the case in Dover and Norway townships, the surface soil is lighter and somewhat more friable and the subsoil is less plastic than typical. There are some inclusions of Miami silty clay loam, Miami silt loam, Carrington silt loam and Clyde silt loam.

Topography and drainage.—The topography ranges from almost level to undulating and gently rolling. Drainage is somewhat deficient on account of the heavy compact nature of the subsoil and tile drains have been installed in a number of places. Little serious erosion is apparent as the run-off is usually gentle. All of this soil has been derived from glaciated material

formed by the grinding action of ice upon limestone rock. The lime carbonate has been leached from the surface soil in almost all places and an acid condition is not uncommon.

Present agricultural development.—This is a prairie soil and the native vegetation was chiefly prairie grasses, the only timber occurring near the contacts with other types and along a few of the streams. The forest growth in such places consisted of oak, maple, basswood, elm and hickory. Practically all this type is or has been under cultivation. The prevailing system is based upon general farming combined with dairying, although sugar beets are grown extensively and cabbage to a less extent in the central and eastern parts of the area. Corn, hay, oats, and barley are the leading crops, corn and hay occupying the largest acreages. Many farmers have a few acres in wheat and a few in alfalfa, buckwheat and hemp. Hemp is grown chiefly in the vicinity of Union Grove where there is a hemp factory. There is also a pickling and canning station there, and cucumbers and cabbage are grown to a considerable extent also. The yields of the general farm crops on this soil equal or exceed the average yields on the other soils in the county.

By far the greater proportion of farmers on this soil do not follow any definite system of crop rotation. The most common rotation consists of corn, followed by a small grain for 1 or 2 years and then by timothy and clover. Hay may be cut for 2 years and the field pastured for a year before again being manured and plowed for corn. Another rotation sometimes followed consists of sod manured and broken for corn, followed by sugar beets or cabbage, then by a small grain, and followed in turn by grass or hay. Stable manure is about the only fertilizer used for general farm crops. For special crops, such as sugar beets and cabbage this is frequently supplemented with commercial fertilizer at the rate of about 150 pounds or more per acre for sugar beets and 500 to 700 pounds per acre for cabbage. The use of commercial fertilizers is gradually increasing.*

Farms on the Carrington clay loam have a selling value of $75 to $250 per acre, depending upon drainage, location, improvements, and character of the soil.

*For a discussion of the chemical composition and management of this type of soil see page 36.

CARRINGTON SILT LOAM

Extent and distribution.—The principal occurrences of the Carrington silt loam are southwest of Pleasant Prairie, northeast of Bristol, northwest of Waterford, and northwest of Corliss. Small areas are mapped in all parts of Kenosha county, except in the southwest corner and in the extreme eastern part. It occurs in all the townships of Racine county except Waterford, Rochester, Burlington, Dover and Mt. Pleasant. Its total extent is 9,920 acres. A few acres of loam and fine sandy loam are included with the silt loam types.

The loam areas lie in the townships of Wheatland, Brighton, Pleasant Prairie, Yorkville, Mt. Pleasant, Raymond and Burlington, and the fine sandy loam areas in a few small patches in the townships of Wheatland, Brighton, Pleasant Prairie, Waterford and Norway.

Description.—The Carrington silt loam to an average depth of 12 inches consists of a dark brown or nearly black friable silt loam, containing a comparatively large amount of organic matter. This layer according to the litmus test is in an acid condition. The subsoil consists of an upper layer of a dark yellowish brown silty clay loam extending to a depth of about 18 inches and a lower layer of yellowish brown clay, in many places carrying small quantities of limestone gravel. The subsoil becomes quite calcareous below 27 to 30 inches and normally in this layer there is a slight mottling of grayish color caused by the excess calcium carbonate present.

Along the boundary lines between the Carrington silt loam and the Carrington loam or fine sandy loam the surface soil normally carries considerable more fine sand than away from these boundaries and the clay subsoil is comparable to that of the Miami silt loam, being much more sandy and porous than is typical. Where this type is associated with the Carrington clay loam, as is the case in the townships of Bristol and Mount Pleasant. The subsoil is heavier and is more mottled in the lower part than typical, and where it borders the Miami soils it is lighter in color and runs lower in organic matter.

Included with this type are mapped small areas of Miami clay loam, silt loam, Carrington clay loam, and Clyde silt loam. All of these, however, are in areas too small to be indicated on the soil map.

Several small areas of the Carrington loam and Carrington fine sandy loam also are included with the Carrington silt loam, because their size do not warrant showing them as separate types.

The surface soil in these loam areas consists of 10 inches of a dark brown to almost black friable loam, containing a comparatively large amount of organic matter and relatively large proportions of fine sand and silt. The upper part of the subsoil is a dull brown to lighter colored clay loam, passing at about 18 inches into a yellowish brown sandy clay that becomes heavier with increasing depth. This continues to a depth of 36 inches or more. Considerable quantities of fine gravel are encountered in both soil and subsoil.

In the fine sandy loam areas, the surface soil to a depth of 8 to 10 inches is a dark brown fine sandy loam, like the loam rich in organic matter. A small quantity of gravel is scattered over the surface of many areas. Tests indicate that the soil is in an acid condition. The upper subsoil is a yellowish brown fine sandy loam grading at about 20 inches into a yellow clay or sandy clay loam. In the lower subsoil a yellowish sandy clay is often encountered.

Topography and drainage.—The topography of this soil and of the included loam and fine sandy loam is gently rolling to rolling. The drainage is usually well established, though in some of the more level areas it is somewhat deficient and tiling is needed. The structure of both the soil and subsoil is usually favorable for the retention of moisture. Although comparatively inextensive, the Carrington silt loam is an important type. It has been derived from the glaciated limestone material which covers the region. The dark color is due to an accumulation of organic matter resulting from the decay of rank vegetation in the presence of considerable moisture.

*Present agricultural development.**—Almost all of this type, and small inclusions of other types occurring in the western part of the area, is devoted to dairying in conjunction with general farming, and about 10 per cent of it occurring in the townships of Mt. Pleasant and Bristol is used for the production of sugar beets and cabbage.

As in the case of the Carrington clay loam, this is a prairie soil, the native growth consisting almost exclusively of prairie grasses.

*For chemical composition and methods for the improvement of this soil see page 36.

A SOIL SECTION IN WAUKESHA SILT LOAM

This view shows the underlying beds of gravel at a depth of about two feet.

A well constructed storehouse on a truck farm in southeastern Wisconsin. Such buildings are used for storing such crops as cabbage, onions, etc.

Corn, hay, oats, barley, wheat, sugar beets and cabbage are the leading crops, with yields slightly higher than on the Carrington clay loam.

Land of the Carrington silt loam type sells for $100 to $250 an acre, the price varying with the location, improvements and condition of the soil.

WAUKESHA SILT LOAM

Extent and distribution.—The Waukesha silt loam, which is not extensively developed in this area has its chief occurrences between Twin and Powers Lakes, in the terrace or bench lands along the Fox and Desplaines Rivers and their tributaries. It is also mapped on an outwash plain west of Waterford. Other very small patches are found in practically all townships of the area. It covers an area of 3,840 acres.

Description.—The surface soil of the Waukesha silt loam, which has an average depth of 12 inches, consists of a dark brown to black, friable silt loam containing a relatively large proportion of organic matter. The upper subsoil is a yellowish brown silt loam grading into silt loam or silty clay loam. At about 20 inches a layer of sandy clay is encountered and this at 20 to 30 inches passes into gravelly sand loam. From 30 to 36 inches, there occurs stratified beds of gravel and sand in which limestone material predominates. In places, the dark brown silt loam of the surface grades at about 10 inches into a yellow sandy loam which passes at 16 to 24 inches into stratified beds of gravel and sand. The Waukesha silt loam as mapped includes patches of Waukesha loam too small to warrant separation.

Topography and drainage.—The surface of the Waukesha silt loam varies from level to very gently undulating, and the natural drainage is good.

*Present agricultural development.**—Practically all the type is under cultivation. It is used chiefly for general farming combined with dairying. It is comparatively easy to plow and a very good seed bed can be prepared without difficulty.

Corn, hay, oats and barley are the chief crops, corn occupying the largest acreage. Wheat and potatoes are grown on a small scale. Corn yields an average of about 40 bushels, oats

*For chemical composition and methods for the improvement of this type of soil see page 36.

45 bushels, barley 40 bushels, and clover and timothy hay from 1 to 1½ tons per acre.

The selling price of this land ranges from $100 to $200 an acre, depending upon the location, improvement and condition of the soil.

Waukesha silt loam, deep phase.—The surface soil of the Waukesha silt loam, deep phase, consists of dark brown to almost black smooth silt loam, high in organic matter and relative high in silt. The upper subsoil is a dull brown silt loam grading downward into a yellowish brown silt loam. This may continue to a depth of 3 feet, but ordinarily a yellow silty clay loam is encountered at about 30 inches. At depths ranging from 3½ to 7 feet beds of gravel and sand occur.

The only important development of this phase is found in a comparatively large area lying between Twin Lakes and Powers Lake. This area represents a part of a rather extensive glacial outwash plain. Other areas lie northwest of Waterford and southeast of Browne Lake. This phase covers 1600 acres.

The surface like that of the typical soil, is flat to very gently undulating and the natural drainage is for the most part good, but there are places where tile drains would be beneficial.

Practically all the phase is under cultivation. It is devoted to general farming in conjunction with dairying. Corn, hay, oats and barley are the leading crops. Sugar beets and cabbage are important special crops. Small amounts of wheat and potatoes are produced. Corn yields 30 to 70 bushels, barley 30 to 50 bushels, oats 30 to 65 bushels and clover and timothy hay about 1½ tons per acre. Sugar beets produce from 8 to 22 tons per acre, and cabbage from 8 to 20 tons.

Comparatively few farmers follow a carefully worked out crop rotation. Where corn is followed by small grain, the land then seeded to clover and timothy and this sod is well manured before plowing again for corn, there is a marked improvement in crop yields. Sugar beets and cabbage commonly take the place of corn in the rotations.

MIAMI CLAY LOAM

Extent and distribution.—The Miami clay loam is the second soil, in point of extent, and one of the most important types in the area. It is widely distributed throughout the two counties,

except in the western morainic region, and immediately along the lake shore on the lake terrace. It covers an area of 56,384 acres or 14.5 per cent of the two counties.

Description.—The surface soil of the Miami clay loam consists of a light brown heavy silt loam, which gradually becomes yellowish in color and somewhat heavier in texture with increasing depth. At 8 to 12 inches it is underlain by a rather plastic and compact yellow silty clay loam slightly mottled with gray and at 15 to 24 inches by a very compact calcareous clay with yellow, brown, and gray mottlings. This may continue to a depth of more than 3 feet, but in many places a rather friable, silty, calcareous clay occurs below 24 inches. This type differs from the Miami silt loam in that the subsoil is heavier, is freer from coarse material and quite uniformly mottled.

Topography and drainage.—The surface ranges from undulating to gently rolling. Because of the heavy character of the subsoil the internal drainage is somewhat deficient. The surface drainage prevailing is usually adequate, although in places artificial drainage is essential to the best results, and the use of tile drains would prove profitable over a considerable proportion of the type.

Origin.—The Miami clay loam has been derived from glaciated limestone debris deposited chiefly as ground moraine. The percentage of clay in this deposit is much higher than in most of the glacial material in this part of the state. The deep subsoil is normally well supplied with lime carbonate and in places the subsoil at 24 inches shows an appreciable amount present, but in many places the surface soil has been leached to such an extent that it now gives a slight acid reaction.

*Present agricultural development.**—The original forest growth consisted of several varieties of oak, hickory, basswood, maple, some walnut and cherry. Practically all of the merchantable timber has been removed from and approximately 80 per cent of the land is now under cultivation. General farming combined with dairying is the leading type of agriculture. The chief crops and the unusual yields obtained are as follows: Corn 25 to 70 bushels, oats 32 to 75 bushels, hay from three-fourths to 2 tons, sugar beets from 6 to 16 tons with an average of 8 tons, and cabbage from 6 to 17 tons with an average of 8 or 9 tons per acre.

*For a discussion of the chemical composition and methods for the improvement of this soil see page 36.

Comparatively few farmers follow a carefully worked out rotation, although corn is followed by small grain and the land then seeded to clover and timothy. The clover sod is well manured before being plowed for corn. This results in a marked improvement in the yields of following crops. The special crops often take the place of corn in the rotation.

Farms on this soil range in value from $75 to $200 per acre, depending upon the location, improvements and condition of the soil.

SUPERIOR CLAY LOAM

The Superior clay loam to a depth of 6 inches consists of brown silt loam containing sufficient coarse material to make it feel slightly sandy. This material grades into a yellowish brown silty clay loam, sometimes mottled and at about 14 inches into the heavy pinkish red clay characteristic of the Superior subsoils. The clay, which extends to an undermined depth, is uniform throughout the soil section below 18 inches.

Only one small tract of 320 acres was mapped. This lies along the Root River in Caledonia township. The surface is level and the natural drainage is somewhat deficient. The subsoil is calcareous, but the surface may be slightly acid in places. A forest chiefly of oak, hickory and maple formerly covered this type. Most of this now has been removed. Probably 80 per cent of this soil has been placed under cultivation. The crops common to the region are grown with success, but the type would be improved by the installation of tile drains. The other methods of improvement mentioned for the heavy soils of the Miami series are well suited to this soil.*

MIAMI SILT LOAM

Extent and distribution.—With the exception of a few small areas in the western part of Norway, Dover, and Brighton townships this soil is confined to Waterford, Rochester, Burlington, Wheatland and Randall townships. It occurs principally in the terminal and recessional moraine areas and covers a total area of 15,488 acres.

Description.—The Miami silt loam to an average depth of 10 inches, consists of a light brown friable silt loam with a relative

*For a discussion of the chemical composition and methods for improvement of this soil see page 36.

large proportion of fine sand and an appreciable admixture of gravel. The content of organic matter is low. Where the silt content is highest the soil is usually fairly free from gravel and sand.

Truog and litmus tests show that this soil is slightly acid at the surface. The upper subsoil is a yellowish brown sandy silt loam which passes at about 16 inches into a reddish or yellowish brown sandy or gravelly clay loam. At about 24 inches yellowish and reddish gravelly sandy clay is found, and this is uniformly calcareous. In a number of areas the lower subsoil consists of a gravelly fine sandy loam. In the SW¼ of the NE¼ of See. 32, T. 4 N., R. 19 E, the subsoil below 24 inches consists of a gravelly fine sand or gravelly sand. As mapped the type has many inclusions of Miami loam and Miami silt loam, deep phase.

Topography and drainage.—It has for the most part a rolling surface. In places it is decidedly hummocky and ridgy. Both the surface drainage and underdrainage are good. In some of the small areas occurring on narrow ridges or kames, or where beds of sand or gravel are present in the lower subsoil, the type is droughty.

*Present agricultural development.**—The silt loam is of minor importance in this area. About 75 per cent of it is under cultivation, the remainder being forested. The principal trees are white, red and black oak, maple, hickory, and basswood, and there is some walnut and cherry.

Corn, oats, alfalfa, clover, timothy and barley are the leading crops. Wheat and buckwheat are grown by a few farmers. Sweet corn for the Milwaukee market is an important crop in Waterford township.

Stable manure is the only fertilizer used. The rotation followed by a number of farmers is corn planted on sod land, followed by a small grain for one year, and then, after manuring, corn for another year. This is succeeded by a small grain, and this by hay for two years.

This type has a value of $60 to $200 an acre, depending upon the location, extent of improvements and topography.

*For a discussion of the chemical composition and methods for improvement of this soil see page 36.

MIAMI SILT LOAM DEEP PHASE

Extent and distribution.—The Miami silt loam deep phase is confined chiefly to the morainic parts of the area, and cover 31,808 acres. The most extensive developments are in the western tier of townships. Other areas occur in Norway, Dover, Brighton, Salem, Bristol, Mt. Pleasant and Somers townships.

Description.—To a depth of 10 inches the Miami silt loam deep phase consists of a light brown or grayish brown friable silt loam, containing a comparatively small quantity of organic matter. In places it carries an appreciable amount of fine sand, but typically it has a smooth velvety feel. Where the silt content is high the material is usually free from stones and fine gravel. The lower part of the surface soil becomes yellowish, and at 12 or 13 inches the material passes into a pale yellowish silt loam, and this at 16 inches into a yellowish silty clay loam, carrying some fine gravel and sand. At a depth of 24 inches a clay loam is encountered, and this continues to a depth of more than 3 feet. The subsoil below 30 inches may be moderately calcareous.

A notable variation is found in the early Wisconsin drift east of Twin Lakes, where the surface soil consists of a light brown, friable silt, 12 to 14 inches deep. When dry the surface presents an ashen appearance, and the proportion of gravel, bowlders and fine sand is noticeably less than in the typical soil. The subsoil here consists of a yellowish silt loam which becomes heavier with increasing depth, grading at 24 inches into a silty clay loam, which at about 36 inches shows in many places a slight mottling of gray. In this variation no lime reaction can be had in the material within 40 inches of the surface.

Where this type is associated with the Miami silty clay loam or Carrington silty clay loam the subsoil at depths ranging from 15 to 20 inches is a rather heavy, compact, yellow clay which continues to a depth of 3 feet or more, and the lower subsoil shows more or less mottling. In depressions, lower slopes, and over level tracts the soil is deeper than typical, while on steep slopes, ridges and knolls more or less of the soil has been washed away and the sandy clay may be exposed. In the western part of the area small bodies of the type are included which have a reddish brown soil and a reddish yellow subsoil.

VIEW SHOWING SECTION OF MIAMI SILT LOAM, DEEP PHASE

In this phase the unassorted gravelly glacial till is found at a depth of over three feet. In places the silty covering is over five feet deep.

VIEW SHOWING SECTION OF THE SOIL IN MIAMI SILT LOAM

In the typical soil the covering of silty material over unassorted till is much thinner than in the deep phase. Both the typical soil and the deep phase comprise good farm land, and this is one of the important types of soil in the area.

Topography and drainage.—The surface features of this type range from undulating to gently rolling, and the natural drainage is good. The internal drainage is much better than in the Miami clay loam areas. Along some of the lower slopes and in depressions between hills and ridges there is some land that would be benefited by tile drains, but the type as a whole is not in need of artificial drainage.

Origin.—This soil is derived from glaciated limestone material. Because of lime rock entering into its composition the deep subsoil is not acid, but the surface and upper subsoil, having been subjected to long periods of leaching in many places show a slight acid reaction.

*Present agricultural development.**—The native forest growth consists of several varieties of oak, maple, hickory, basswood, walnut and cherry. Practically all of the merchantable timber has been cut and probably 75 per cent of the land is under cultivation. General farming in conjunction with dairying is the prevailing type of agriculture. Corn, hay, oats, barley and wheat are the leading crops, ranking in importance in about the order named. Irish potatoes, rye, alfalfa, and buckwheat are grown in a small way. There are some apple orchards but none of commercial size. The fruit is usually of an inferior quality, owing largely to neglect to prune or spray the trees properly.

The yields of the general farm crops are as a rule fairly satisfactory and range a little higher than on the clay loam. The rotation most commonly followed consists of corn, followed by a small grain crop for two years, and then by timothy and clover. Hay may be cut for two years, before the land is plowed again for corn. Sometimes the field is pastured a year following the taking off of the hay crops.

The value of land of this character ranges from $75 to $200 or more per acre, depending upon the location, improvements and condition of the soil.

FOX SILT LOAM

Extent and distribution.—This soil covers a total of 15,616 acres.

*For a discussion of the chemical composition and methods for improvement of this soil see page 36.

The largest areas of this type occur in the glaciated outwash plains west of Wilmot, in the vicinity of Powers Lake, west of Waterford, and north of Burlington. There are many other areas, ranging from a few acres to several hundred acres, scattered throughout Kenosha county and in the western half of Racine county. These areas also occupy glacial outwash plains or stream or lake terraces.

Description.—The surface soil of the Fox silt loam consists of 10 inches of light brown or grayish brown friable silt loam. This is underlain by a yellow silt loam which grades at about 15 inches into a silty clay loam. At about 24 to 30 inches a brown gravelly or sandy clay loam is often present and at from 32 to 36 inches this is underlain by beds of sand or gravel which carry a high percentage of limestone material. In many cases a fine sandy loam is found at 2 to 3 feet below the surface, and in other cases the yellow clay loam changes to a silty clay loam at about 22 inches and extends to a depth of about 30 inches.

The Fox silt loam where it is associated with the Carrington silty clay loam and Miami silty clay loam is heavier than typical and the subsoil is often a yellow clay loam passing into a rather compact sandy clay that shows some brown and yellow mottling in the lower depths.

Topography and drainage.—The surface of this type is flat to very gently undulating and the natural drainage is good. In places where the subsoil is heavier than typical the underdrainage is sometimes slightly deficient in which case tile drains could be used to advantage.

*Present agricultural development.**—The original forest growth on this soil consisted of several varieties of oak, hickory, basswood, elm, ash, and some maple. Most of the merchantable timber has been removed.

Although of comparatively small extent, the Fox silt loam is an important type. Practically 95 per cent of it is under cultivation. General farming in conjunction with dairying is the type of agriculture. Some trucking is done on this soil on the Lake Michigan terrace near Berryville.

The leading crops are hay, corn, oats, barley and wheat. Some special crops, chiefly cabbage and onions are grown on

*For a discussion of the chemical composition and methods for the improvement of this soil see page 36.

the lake terrace areas. The yields of most of the farm crops are as a rule satisfactory and compare favorably with those on the types of the same texture in the Miami and the Carrington series. The methods of cultivation, the crop rotations, and the use of fertilizers are essentially the same as on the Miami silt loam.

Fox silt loam heavy subsoil phase.—The surface soil of the Fox silt loam, heavy subsoil phase consists of 10 to 12 inches of light brown friable silt loam, low in organic matter. Below this the material passes into a yellow silt loam, which at about 16 inches grades into a yellowish silty clay loam. This becomes heavier with depth, grading at 26 to 30 inches into a silty clay. At about 3 feet or a little less heavy yellow compact clay is encountered. This may be slightly mottled. Stratified beds of sand and gravel occur at varying depths below 4 feet.

This phase is not extensively developed, and on the map is included with the typical soil. It has its chief occurrence on the glacial terrace between Powers and Twin Lakes. A few small areas occur east of Paris, north of Burlington, south of Caldwell, and southwest of Pleasant Prairie.

The surface is level to very gently undulating and natural drainage is good, although in some places tile drains would be beneficial.

The materials forming this phase are all waterlaid, having been deposited as glacial, as outwash plains, or as terraces along streams. Practically all of the merchantable timber has been removed and a large proportion of the land placed in cultivation. Under normal conditions this phase gives slightly higher average yields than the typical soil. The methods of cultivation followed, the rotations, and fertilizer practices are the same as on the Miami silt loam. As with other light colored soils of the region this phase of the Fox silt loam is deficient in nitrogen, organic matter and phosphorus.

Fox silt loam, gray sandy phase.—The areas mapped as the gray sandy phase of the Fox silt loam are in reality the Fox fine sandy loam but were given a phase designated on account of their small extent. On the published map this phase is included with the typical soil.

The surface of this soil to a depth of 8 inches consists of a light brown or grayish fine sandy loam. This is underlain by

a pale yellowish fine sandy loam that extends to about 14 inches, gradually becoming heavier with depth. The subsoil ranges from a heavy pale-yellow fine sandy loam to a sandy clay loam. In places this material extends to a depth of 3 feet or more, but commonly a bed of sand and gravel is found at depths between 2 and 3 feet. In the northeastern part of Sec. 1 and the north-central part of Sec. 13, T. 2 N., R. 22 E., there are included with this type some small ridges that might have been mapped as gravelly sandy loam, had they been of sufficient extent.

The Fox silt loam, gray sandy phase is of very small extent. It is developed mainly on the terraces of Rock River, although small areas lie on the Lake Michigan Terrace and other terraces, as well as in the outwash plains in some parts of Kenosha county and the northern part of Racine county. The surface of the areas is flat to very gently undulating. The drainage is good, except in a few small areas where the water table lies near the surface.

The soil is all of alluvial origin, having been deposited by water issuing from beneath the ice or on terraces along streams. While most of the material has come from glacial limestone debris, the surface layer is in many places slightly acid, owing to the long period during which it has been subjected to leaching.

Probably 50 per cent of this soil is under cultivation. Of the remainder being used for grazing, some of the land being in the unimproved state, with a scattered growth of oak, maple hickory and basswood. Most of the merchantable timber has been removed. General farming in conjunction with dairying is the chief type of agriculture. Corn, hay, oats, barley and some wheat are grown, and fair to good yields are obtained.

CHEMICAL COMPOSITION AND IMPROVEMENT OF GROUP OF HEAVY SOILS

This is by far the most important and extensive group of soils in Kenosha and Racine counties. The group covers about 64 per cent of the area or a total of approximately 247,000 acres. The Carrington and Waukesha soils include the prairie lands and the soils are dark colored, and high in organic matter, while the Miami, Superior and Fox soils are light colored and include land which was originally timbered, and which is usually de-

ficient in organic matter and nitrogen. The clay loam types are of course heavier in texture and somewhat more difficult to handle than the silt loams, but from the standpoint of chemical composition and methods of improvement the soils of the group are closely enough related so that they may be discussed as a group rather than as individual types.

The four elements of plant food with which the farmer is most concerned in his farming operations, and the ones which are the most apt to be deficient are nitrogen, phosphorus, potassium and lime or calcium. He should know the part which each plays in the development of the plant, and what are the best methods of maintaining an adequate supply in the soil.

The soil has been leaching for a large number of years, and has lost some of the lime which it contained. Varying degrees of acidity have developed over the region. The loss of lime from the soil is caused by two distinct factors, both of which are important. Crops require lime in their growth. A 5 ton crop of alfalfa requires 185 pounds of lime and 2 tons of red clover remove 61.6 pounds. A much larger amount is removed by leaching each year and when the total supply is limited, these losses must be made up by the application of lime in order to maintain the fertility of this soil.

While it will be seen from tests that a considerable part of this land shows some degree of acidity it does not mean that all of the land is in immediate need of lime. In fact plot tests show that much of the land does not respond profitably to liming. In most cases the subsoils are well supplied with lime and frequently the surface is only slightly acid or not acid. The dark colored soils usually show more acidity than the light colored types. Where such crops as alfalfa, sugar beets, tobacco, peas, cabbage and other garden crops are grown and where the acidity is medium from 2 to 3 tons per acre of ground limestone may be used with profit.* Where a liberal supply of manure is available the need for lime will not be so great. The second application which may be needed after 4 or 5 years will be less than the first.

Where such crops as corn, clover and oats are grown with manure once during each rotation a smaller amount of lime will be needed. On parts of the farm where manure cannot be

*For a more complete discussion of the subject of liming see page 79.

applied the lime can be used with profit on such soils and may be actually necessary for economic production.

It has been quite definitely established that the need for lime in these soils runs practically parallel with the need of phosphorus. In the improvement of these lands, which are acid, therefore, provision for the use of both lime and a phosphate fertilizer should be made whenever the soil shows a lack of fertility.

Phosphorus exists in all soils in Wisconsin in small amounts. Many of the best types in the state contain only 1,200 pounds to the acre eight inches deep, and this is in a form which becomes available to crops very slowly. This amount is considered a medium supply and it is desirable to increase it. Phosphorus is constantly being lost from the farm in crops, milk and in the bones of animals sold. It is well understood that when grain, hay, potatoes or other cash crops are sold, this element is removed from the farm. This element cannot be supplied from the air and in the long run the loss must be made up through additions of phosphorus fertilizer in some form.

Analysis of eighteen samples of Carrington clay loam from this area gave an average of 1,555 pounds of phosphorus per acre. In 9 samples of Miami silt loam the average amount of phosphorus present was 1,091 pounds per acre. Three samples of Miami clay loam averaged about 1,000 pounds per acre each. The lowest amount found in any of the samples was 840 pounds per acre. The number of pounds of phosphorus in the soil, however, cannot be taken to indicate the immediate need for phosphate fertilizer. The system of farming followed, crops grown, type of soil and conditions relative to acidity are all important factors in determining the need for phosphorus. It should also be borne in mind that where soils are acid the phosphorus which they do contain is not so readily available to plants as in soils which are not acid.

On good upland soil where dairying or general farming is practiced the use of 200 pounds of 16 per cent acid phosphate or 75 pounds of 44 per cent super-phosphate to the acre every 3 or 4 years will maintain the phosphorus supply. If much grain, potatoes or other crops are sold, more phosphate should be used. A number of demonstrations of the use of limestone

and phosphate fertilizers have been made in Wisconsin by the experiment station.*

If considerable amounts of bran or cottonseed meal are fed, which are relatively high in phosphorus, the supply of this element may be maintained. It would usually be necessary to feed at least one-half ton of bran or cottonseed meal to each cow on a dairy farm per year to maintain the phosphorus supply of the soil. Since comparatively few farmers do that some phosphate fertilizer should be used.

Potassium exists in these soils in large amounts, but in relatively unavailable form. Chemical analyses show that these heavy soils often contain from 30,000 to 40,000 pounds an acre eight inches, while these same soils will contain only one-eighteenth as much phosphorus. On most soils of fairly heavy texture, when live stock is maintained, and the manure carefully used so there is considerable actively decomposing organic matter in the soil, a sufficient amount of potassium will become available from year to year to supply the needs of general farm crops. There are some crops that need relatively large amounts of potassium such as potatoes, tobacco and cabbage and they will often be benefited by some addition of potash in the form of commercial fertilizer.

Nitrogen is chiefly responsible for the dark green, healthy color and rapid growth of corn or other crops on well manured land. It is important to have sufficient amounts in the soil, but when in excess it is detrimental for some crops. The quality of the grain may be injured by too much nitrogen. When the grain lodges the kernels do not fully mature.

Virgin soils contain large amounts of nitrogen but if they are cropped continuously to such crops as corn, oats and timothy without the addition of fertilizer material containing nitrogen the nitrogen supply is gradually exhausted and the yields are reduced.

The supply of organic matter and nitrogen in the prairie soils is higher than in the light colored timber soils. Four samples of Carrington clay loam averaged about 6,000 pounds of nitrogen per acre. This amount is considered a very good supply. A question of importance in connection with the nitrogen of this soil, however, is its availability to plants, and in the soils

*See review of the results of these tests on page 81.

which have been under cultivation for a long number of years, this nitrogen is somewhat inert, and when in this condition, decaying vegetable matter, green crops, or manure plowed under will give a more readily available suply of nitrogen. Nine samples of Miami silt loam averaged 3,060 pounds per acre or about one-half the amount in Carrington clay loam. Four samples of Miami clay loam showed practically the same amount as in the silt loam. Efforts should be made to increase the nitrogen and organic matter content of these light colored soils.

The clover, alfalfa, peas and beans have bacteria on their roots that take the free nitrogen from the air and store it in the plant. This is the cheapest method of obtaining nitrogen and one which the farmers should use to the fullest extent. On the ordinary dairy at least one-fourth of the land under cultivation should be seeded to clover or alfalfa. This should be fed to stock or plowed under as green manure to insure keeping up the supply of nitrogen and organic matter.

A rotation with a legume plowed under will secure nitrogen and reduce danger from diseases, and when supplemented with phosphorus and lime the legumes thus treated will take the place of manure, which can then be used for other crops on the farm.

Certain crops, such as tobacco, potatoes and vegetables, are grown by farmers who do not keep much livestock and who do not rotate these crops with legumes. This is not a good practice.*

*Reasons why this is not a good practice are discussed under crop rotations on page 76.

CHAPTER III

GROUP OF LOAMS AND FINE SANDY LOAMS

FOX LOAM

Extent and distribution.—The Fox loam is distributed in small areas in the western, southern and eastern parts of the survey. It occupies a total area of 4,608 acres. Most of these occur in the glacial outwash plains between Wilmot and Powers Lake, on the terraces of the Fox and Desplaines Rivers and on the Lake Michigan terrace.

Description.—The Fox loam to an average depth of 10 inches, consists of a light to medium brown loam. Below this depth the material takes on a yellowish color and becomes a friable sandy clay loam, which normally carries some gravel. At 20 inches a gravelly sandy clay is encountered and this grades into beds of gravel or sand, at from 26 to 30 inches. In some places the underlying coarse material lies within 18 inches of the surface; in others it is not found within the 3-foot section. The underlying gravel and sandy layers carry a high percentage of limestone material. There are some included areas of fine sandy loam and silt loam that are too small to map.

Topography and drainage.—The surface of this type is level to gently undulating and the drainage is good. The soil is open and porous and readily absorbs the normal rainfall.

The Fox loam is of alluvial origin, having been deposited by water issuing from beneath the ice sheet or as terraces along swollen streams. The material comes from the glaciated limestone debris which forms the adjoining uplands.

*Present agricultural development.**—Though nearly all of the Fox loam is under cultivation, it is inextensive and, therefore, of little importance. It is a good soil and is devoted to the production of most of the general farm crops common to the region. The methods of farming followed and the fertilization and rotations used are practically the same as on the Miami soils

*For a discussion of the chemical composition and methods for the improvement of this soil see page 47.

of similar texture. The Fox loam is easy to cultivate and a mellow seed bed is readily formed.

MIAMI LOAM

Extent and distribution.—The Miami loam is of rather small extent covering 4,592 acres. It occurs in the extreme western part of the area in Wheatland township, and in that part of the area which borders Walworth county. It also occurs in the western parts of Salem, Brighton, Dover and Norway townships.

Description.—The surface soil of the Miami loam consists of 8 or 10 inches of a light brown loam containing relatively large proportions of silt and fine sand. The subsoil is a yellowish brown loam which grades into a silty clay loam at about 14 inches. This may continue to a depth of 3 feet or more, or it may change at any depth within the 3 foot section below sixteen inches into a yellowish fine sandy loam. Gravel is common below 30 inches. In some places the subsoil is composed entirely of clayey fine sandy loam. Included areas of silt loam and fine sandy loam too small to map are very common.

Topography and drainage.—The surface varies from gently rolling to rolling and the natural drainage is good. The structure of both soil and subsoil is usually favorable for the retention of moisture. However, there are places on narrow ridges and knolls where the gravel is near the surface and the soil droughty. On some of the areas erosion is severe and deep gullies and ravines have developed.

*Present agricultural development.**—General farming in conjunction with dairying is the principal type of agriculture. Probably 75 per cent of the type is cultivated. The remainder is used as permanent pasture or is in forest consisting of several varieties of oak, maple, hickory, basswood, elm and walnut. All of the common farm crops of the region do well on this soil. Corn, hay, oats and barley are the principal crops. Alfalfa is well adapted to this soil and is grown on many farms. Wheat and buckwheat are produced in a small way. The methods of handling this soil and the yields obtained are essentially the same as in the case of the Miami silt loam.

*For a discussion of the chemical composition and methods for the improvement of this soil see page 47.

The selling price of this land ranges from $60 to $125 an acre, depending largely upon the proportion of cleared land, the topography, erosion, location and improvements.

Gravelly phase.—The surface soil of the Miami loam, gravelly phase, consists of 6 to 8 inches of a light brown loam or fine sandy loam, carrying varying quantities of rounded limestone, quartz, chert, and crystalline rock gravel. The upper subsoil is a yellowish-brown loam also with some gravel. At about 14 to 16 inches this passes into a gravelly sand clay loam and in many places at 30 inches into a gravelly loam or beds of gravelly sand.

The phase is of very small extent covering about 320 acres. It is found chiefly in small areas southwest of Rochester and north of Bolmer Lake. The surface ranges from rolling to broken. Except in kettle holes and other basins the drainage is good to excessive. The material forming this type has been derived from glaciated limestone debris which has been deposited as moraines. Inasmuch as there is a large amount of lime present the soil is not acid and the subsoil is strongly calcareous. Probably 20 per cent of this type is under cultivation. The remainder is covered with a growth of oak and hickory. Corn, oats, rye, alfalfa, clover and timothy are the principal crops. The yields obtained, methods of handling and fertilization are about the same as employed on the Miami fine sandy loam. Only the least rolling parts of the gravelly loam should be cultivated; the remainder should be seeded to grass or alfalfa, which does especially well on this soil. The maintenance of the supply of organic matter requires special attention.

MIAMI FINE SANDY LOAM

Extent and distribution.—Miami fine sandy loam is of limited extent in Kenosha and Racine counties, being confined almost entirely to a number of small areas well scattered throughout the western half of the area. The total area is 3,200 acres.

Description.—The surface soil of this type to an average depth of from eight to ten inches consists of a light brown fine sandy loam which contains only a small amount of organic matter and is often in an acid condition. This is underlain by a yellow fine sandy loam which gradually becomes heavier with increased depth until a sandy clay loam is reached at from 15 to 24 inches.

This continues to a depth of three feet or more. There is often some gravel in both the soil and subsoil.

The type as mapped is not uniform. Frequently in small areas, particularly along the crest of ridges and on steep slopes where the wash has carried away the surface soil the fine sandy loam extends to a depth of only a few inches and rests on a yellowish sandy clay, and at the bases of these slopes where the wash materials have been deposited there is often a surface soil of much greater depth.

Topography and drainage.—The topography is gently rolling to ridgy and very broken and the drainage because of the surface features and the sandy nature of the soil and subsoil, is usually well established. In the more sandy places, the drainage is often excessive.

*Agricultural development.**—Probably 60 per cent of this type is cultivated while the remainder is used for pasture. The timber growth consists of several varieties of oak, hickory, maple, and some walnut and basswood. The crops grown and methods of farming followed are practically the same as on the Miami silt loam and crops mature somewhat earlier.

SUPERIOR FINE SANDY LOAM

The Superior fine sandy loam occurs chiefly in small areas in Caledonia township along Root River, and near Wind Point on the Lake Michigan Terrace. Its total area is only 960 acres.

The Superior fine sandy loam consists of a brown fine sandy loam or very fine sandy loam, underlain at about nine inches by a yellow fine sand. This at about 20 inches passes into a purplish to reddish elastic clay, which at about 26 inches grades into a very calcareous red clay with white seams or splotches of calcium carbonate interspersed through it. From 26 to 36 inches there is no important change. There are shallow basins where the surface soil is a dark brown to almost black fine sandy loam, like the Poygan fine sandy loam. In these basins the upper subsoil is a mottled gray and yellow fine sand grading at about 20 inches into a mottled purple and gray clay, which becomes red at about 26 inches. The surface of these areas is level or only very gently undulating and the natural drainage in places is somewhat deficient.

*For a discussion of the chemical composition and methods for the improvement of this soil see page 47.

The Superior fine sandy loam is of mixed origin. The heavy red clay subsoil is doubtless lacustrine, but has been modified more or less since its original deposition, by the action of the ice sheet. The surface sandy material is probably mostly of glacial origin. The subsoil is usually well supplied with lime carbonate, but the surface is in places slightly acid, owing to its thorough leaching.

Probably 80 per cent of this soil is under cultivation at the present time. The remainder is covered with a growth of oak, maple, elm and hickory. The chief crops grown are corn, oats, barley, hay, sugar beets and cabbage. Where well drained this is a very good soil. It is not difficult to cultivate, a good seed bed being prepared with little effort. Moisture is also retained well because of the heavy subsoil. In the improvement* of the type the same methods may be used as in case of the best Miami soils.

Superior fine sandy loam, heavy phase.—The Superior fine sandy loam, heavy phase, consists of a brown loam about six inches deep underlain by a yellow or yellowish brown material of the same texture to about 10 inches. Below this the material grades into a mottled yellow, brown, and gray silt loam or silty clay loam and then at about 14 inches into a pinkish red plastic clay which extends to depths greater than three feet, becoming redder with increase in depth. This is the typical subsoil of the Superior series, as found in other parts of Wisconsin. Only a small area of this phase exists in the present survey. It is found chiefly in small patches along Root River in Caledonia township. These areas are fairly typical of the Superior loam, but were mapped as a phase of the Superior fine sandy loam on account of the limited extent.

The surface is flat and the natural drainage is somewhat deficient. The original forest growth was chiefly maple, oak and hickory. About 70 per cent of this land is under cultivation, and where drainage is adequate it is an excellent soil, well adapted to most of the crops common to the region. Because of its small extent no farms are located entirely upon it, and no system of rotation or cultivation has been worked out especially for this type. The practices followed upon it are those followed on the more extensive adjoining soils.

*For a discussion of the chemical composition and methods for the improvement of this soil see page 47.

In its improvement drainage is of importance. The supply of organic matter is somewhat deficient, and the phosphorus content is below normal. Suggestions made for the improvement of the heavy Miami soils will also apply to this land.

WAUKESHA LOAM

This soil is of somewhat limited extent, covering a total of 3,648 acres, but it is widely distributed. It consists of small tracts of from a few acres to one-fourth square mile. The most numerous areas are found upon the Lake Michigan Terrace, and along the Des Plaines and Fox Rivers.

The surface soil to a depth of about 10 inches consists of a dark brown to nearly black loam which contains considerable more organic matter than the light colored soils of the uplands adjoining. The subsoil is variable and ranges in texture from a fine sandy loam to a silty clay loam of a yellowish color, which at about 18 inches grades into a sandy yellowish clay. At about 30 inches stratified beds of sand or gravelly material are often found. In the eastern part of Caledonia township in Racine county the surface of this soil is heavier than typical and approaches a clay loam.

The surface of this type is level and is found on terraces along Lake Michigan and also along some of the larger streams of the area. Some of these areas are rather low, but not subject to overflow. The drainage, however, in places is not as good as on Waukesha soils as found in some other parts of the state. This accounts for a slightly mottled condition which is found in the subsoil over limited tracts.

Most of the type is under cultivation.* The portion on the Lake Michigan terrace is devoted largely to trucking while the remainder of the soil is given over mostly to general farming. The same crops are grown as on the Waukesha silt loam. Among the special crops grown are sugar beets, cabbage, onions, carrots, parsnips, tomatoes, melons, etc. In the trucking district commercial fertilizers are used quite extensively to supplement manure, most of which is shipped in.

*For a discussion of the chemical composition and methods for the improvement of this soil see page 47.

WAUKESHA FINE SANDY LOAM

The type is developed most extensively on the Lake Michigan terrace where it forms long narrow strips, extending parallel with the lake shore. Other areas occur on the terraces of the Fox, Desplaines, and Root Rivers, and their tributaries. It includes 3,264 acres of land.

The surface soil of the Waukesha fine sandy loam has an average depth of 10 or 11 inches and consists of a dark-brown or almost black fine sandy loam, containing a relatively high percentage of organic matter. The subsoil is a brownish-yellow fine sandy loam, which at about 16 to 20 inches is underlain by a yellow sandy clay loam. This becomes lighter in texture with increasing depth and passes into a bed of stratified sand and gravel at 30 to 36 inches.

As mapped the type is quite variable. The surface soil of included areas ranges from fine sand to loam. The stratified beds of gravel and sand may be within 12 inches of the surface or may not be encountered within the 3-foot section.

The surface is level to very gently undulating, and the drainage is good, except in a few cases where the ground water level is very near the surface.

Practically all the Waukesha fine sandy loam is under cultivation. On the Lake Michigan terrace it is devoted to truck-ing and in other localities to general farming in conjunction with dairying. Cabbage yields from 6 to 15 tons per acre, corn from 28 to 38 bushels, oats from 25 to 45 bushels, barley from 25 to 40 bushels, rye 15 to 20 bushels, buckwheat from 12 to 18 bushels, wheat 15 to 20 bushels and timothy and clover hay 1½ tons per acre, potatoes about 100 bushels. The rotations followed are practically the same as on the Waukesha silt loam, deep phase, and the methods of improvement suggested for that type are applicable to this soil.

CHEMICAL COMPOSITION AND IMPROVEMENT OF LOAMS AND FINE SANDY LOAMS

In this group of soils there are five separate types all of which are of minor importance individually but collectively the group is important since it covers a total area of 19,072 acres or about

5 per cent of the area. These soils are lighter in texture than the silt loams but where general farming is carried on similar methods of improvement can be followed as outlined on page 36.

While there is some variation in the texture, structure and color of the types of soil in this group there is a sufficient similarity so that general methods of improvements discussed here will apply to the entire group.

Tests and observations which have been made on these soils indicate that most of the types are in need of lime. The dark colored prairie soils show a greater need than the light colored soils. There are a few exceptions to this need.

The supply of organic matter in the dark colored types such as the Waukesha loam and fine sandy loam is somewhat greater than the light colored types but in older cultivated soils this organic matter is in an inactive form so that the introduction of decaying vegetable matter will greatly aid in the improvement of these types regardless of color.

The supply of phosphorus in these loams and fine sandy loams is lower than in the heavier types and these soils show a marked deficiency in this element. The actual number of pounds of phosphorus which these soils contain, however, is not a true index of the actual need of this element. Some of the soils which show a small total amount do not respond as well to an application of the phosphorus fertilizer as do the types which have a large amount present so that the behavior of the crop is a more important indication of the need of phosphorus than the chemical analysis.

Regarding the supply of potassium in the soil the total amount is approximately 25,000 pounds per acre or fully 20 times as much as the supply of phosphorus. Where general farming is conducted and where there is maintained a good supply of vegetable matter in the soil this will doubtless be sufficient. Where special crops are raised which require a large amount of potassium this element may be supplied to advantage in the form of a commercial fertilizer.

The principal characteristics of these types is that they hold somewhat less water than heavier soils do and they warm up more quickly in the spring. This together with the readiness with which they can be worked adapts them to truck and spe-

cial crops, the growing of which requires more hand labor than is involved in the growing of staple crops. It is necessary to give them somewhat more attention to maintain fertility partly because of the fact that they are lower in fertility than the heavier soils but more because of the fact that these special crops require a higher degree of fertility to produce satisfactory yields. When these soils are used for the production of special crops their fertility can be maintained either through the use of rather heavy applications of stable manure or through the use of a rotation in which a legume is grown as the means of securing the necessaray nitrogen and organic matter while the other elements, chiefly phosphorus and potassium, are supplied in commercial fertilizers. When this latter system is followed one-third or one-fourth of the land should be sown to a legume such as clover or soy beans which have large powers of gathering nitrogen from the air, and a part of the phosphorus and potassium should be used for the growth of different green manuring crops. The fertility used in this way will become available for the succeeding crops through the decomposition of the legume when plowed under and the remainder of the fertilizer to be used should be applied on this ground at the time of fitting it for the succeeding crops.

CHAPTER IV

GROUP OF GRAVELLY AND SANDY LOAMS

FOX GRAVELLY LOAM

The type is found in several parts of the Lake Michigan terrace, where it occupies old beach lines that usually extend in a north and south direction, roughly parallel to the present shore line of the lake. There are only 832 acres of this land in the area.

The surface soil of the Fox gravelly loam consists of 6 to 10 inches of a brown gravelly fine sandy loam. This layer is underlain by a yellowish brown material of about the same texture. At 15 to 20 inches the texture in many places becomes heavier, but there may be no change, or in some places the change may be to a gravelly fine sand or gravelly sand. There are many included patches of Fox fine sandy loam the extent of which did not warrant their separation on the soil map. The gravel in this type is small and well rounded and mostly of limestone. The underlying gravelly and sandy beds are highly calcareous.

The loose open structure of the soil and the small quantity of organic matter present tend to make the drainage excessive, and even during normal seasons crops are apt to suffer from lack of moisture.

The soil is of very small extent. It is used principally in the production of early truck crops, but the yields are usually rather low except where large quantities of fertilizer are used.

An area of the Fox gravelly fine sand occurs in the old beach line at the southeastern corner of Kenosha county. It is not extensive enough to show as a separate type. The soil, to a depth of 6 inches consists of a brown to dark brown gravelly fine sand. This is underlain by a brownish yellow fine sand that grades at about 18 inches into a loose yellow fine sand. The area is from 200 to 600 feet wide and about 2½ miles long and extends approximately north and south. Probably 75 per cent of the area is devoted to trucking. With heavy applications of

VIEW SHOWING THE SURFACE FEATURES OF RODMAN GRAVELLY LOAM

This is land of low agricultural value. Much of it is too rough and broken to be cultivated.

VIEW OF ONE OF THE FINE DAIRY BARNS IN SOUTHEASTERN WISCONSIN

The dairy industry is the most important branch of farming followed in this region. Some small grains are also grown, partly for feed and partly as a cash crop.

manure and commercial fertilizers fairly good yields are obtained. The suggestions offered for the improvement of the Waukesha fine sand will apply equally well to this soil.

RODMAN GRAVELLY LOAM

The surface soil of the Rodman gravelly loam consists of 6 inches of a brown, or grayish brown gravelly sandy loam of fine to medium texture. In places there is present a relatively large proportion of silt. With increasing depth the color of the material becomes lighter, and at about 12 inches gravelly sandy clay is encountered. At about 15 inches this grades into a bed of stratified gravel and sand. The surface inch of the soil is in many places quite dark, owing to the accumulation of organic matter. The layer of soil material over the gravel is commonly shallow, but varies considerably. Along the lower slopes the layer is thickest and may reach 2 feet or more. In such places it is the steep topography, rather than the character of the soil itself that determines the grouping of the material with this type. The gravel consists of about 95 per cent limestone, 1 per cent chert, 2 per cent granite-gneiss and 2 per cent other crystalline rocks.

Included with the Rodman gravelly loam are numerous areas which if of sufficient extent would have been mapped as Miami loam, silt loam and fine sandy loam.

The Rodman gravelly loam is confined largely to the western tier of townships. The topography is rough and broken and is usually so steep that modern farm machinery cannot be used.

This soil is derived from glacial debris deposited by the ice sheet in the form of kames, eskers, and very rough moraines.

The native vegetation on this soil consist chiefly of oaks, with some hickory and a few other hardwoods. Only small patches here and there are cultivated. The crops common to the region are grown, usually with indifferent success. Alfalfa does fairly well and is probably the best crop for this type of land. Only the less broken parts of the type should be cultivated, on account of the danger of erosion. This rough land is best suited to grazing and should be kept in permanent pasture. It is a question if much of it could not well be devoted to forestry.

WAUKESHA FINE SAND

The Waukesha fine sand consists of 9 to 12 inches of a dark brown loamy fine sand, underlain at about 12 inches by a rather incoherent yellow fine sand which continues to a depth of more than 3 feet.

The type is developed chiefly on the Lake Michigan terrace. The typical soil is found from Kenosha south to the Illinois-Wisconsin state line. The topography is level to very gently undulating, with low narrow ridges extending approximately north and south and parallel with the lake shore. The drainage is excessive, and the type is somewhat droughty. The material forming this soil was deposited in the lake when that body of water stood at a much higher level than at present. The total area including several variations amounts to 2,908 acres.

Probably 70 per cent of the typical soil is now under cultivation, and is devoted chiefly to truck farming combined with general farming. Sugar beets yield from 6 to 12 tons per acre, potatoes about 125 bushels, cabbage from 6 to 12 tons per acre, onions from 200 to 500 bushels, corn from 15 to 35 bushels, oats from 20 to 40 bushels, rye 15 to 25 bushels, and clover and timothy hay about 1 ton per acre. Tomatoes, parsnips, beans, carrots and melons are also grown with success.

No systematic rotation of crops is followed.* Onions are commonly grown on the same fields for several years in succession. Onion, potato and cabbage land receive from 15 to 20 tons of horse manure per acre. Stable manure is usually not used on sugar beets. Commercial fertilizer of the formula (2-10-2 or 1-8-1) is usually applied to sugar beets, potatoes and cabbage at the rate of 500 to 1,000 pounds per acre, although much heavier applications are sometimes made. Commercial fertilizer is seldom applied for such crops as corn and small grains, the residual effect of application in growing the truck crops being depended on.

The selling price of this land ranges from $50 to $300 or more per acre, depending upon improvements, condition of soil, and location.

There is considerable variation in this type. It includes small areas of Waukesha loamy fine sand and also some tracts of Waukesha fine sandy loam too small to be shown on the soil

*For a discussion of the chemical composition and methods for the improvement of this soil see page 55.

map. In the eastern part of Caledonia township on the Lake Michigan terrace is another phase which is similar to typical Waukesha fine sand except that the subsoil consists of a gray, yellow and brown mottled fine sand, showing a poorer condition of natural drainage than is found on the typical soil.

The surface of this phase, which has been mapped by the Bureau of Soils in other states as Newton fine sand, is level or gently sloping. Adequate drainage has been provided and in places the drainage is excessive. Most of this phase is under cultivation and devoted chiefly to trucking and special crops. It is being farmed the same as the typical Waukesha fine sand, and the same methods of improvement will apply.

In the extreme southeastern corner of Kenosha county on the Lake Michigan terrace, is a small area where the surface is flat to slough-lake and the drainage is very poor. None of the area is used for agricultural purposes on account of its water logged condition.

The surface soil in this area is a dark-brown to almost black fine sand, 9 inches deep running rather high in organic matter. The subsoil is a mucky gray fine sand throughout the subsoil section, but in places it consists of two layers, an upper one of yellow fine sand, and a lower one of gray fine sand, extending from 24 or 30 inches to 36 inches.

Waukesha loamy fine sand, muchy phase.—Only one area of this soil was mapped in Racine county, and none at all in Kenosha county. The total extent is about 40 acres. The area lies on the north shore of Wind Lake. The soil consists of a layer of grayish loose sand 16 to 30 inches deep, overlying a bed of peat. Except in having a peaty substratum this soil is very similar to the Calumet fine sand mapped in Lake county, Indiana.

The surface is level, and only a few feet above the waters of the lake, and the natural drainage is only fair. In the spring when the water in the lake is high the drainage is poor, as the watertable is then quite near the surface.

The peat, subsoil consists of decaying vegetable matter in varying stages of decomposition. The surface soil is sandy material that has been deposited over peat beds in quite recent time. Heavy rains carry considerable quantities of soil material from the surrounding region into this lake. It is evident that the

lake at one time, not many years ago, completely covered all this soil.

The vegetation on this soil consists of coarse grasses, which afford some grazing. The soil has never been placed under cultivation.

PLAINFIELD FINE SAND

This type occurs on the Lake Michigan terrace, where it is confined to long low narrow belts running parallel with the lake shore. It covers an area of approximately 2,000 acres.

The Plainfield fine sand consists of 6 to 8 inches of a brown to yellowish brown, loose, fine sand grading into a yellow fine sand that extends to a depth below 3 feet. In basin-like areas lying between sand ridges or sand dunes the surface material has a darker color than elsewhere, owing to the accumulation of more organic matter.

The surface is level to gently undulating, but everywhere there is evidence of wind action, and in many places a dune topography has developed. Because of its loose, open structure the drainage is excessive.

Only a small part of this soil is under cultivation. Its chief use is for trucking. With heavy applications of stable manure, supplemented by commercial fertilizers, fair yields are obtained. The soil is deficient in nitrogen and the mineral plant food elements and requires very careful management to show a profit. It is doubtless better suited to trucking than to any other sort of farming.

Plainfield fine sand, loamy phase.—The Plainfield fine sand, loamy phase, consists of 9 inches of a somewhat loamy fine sand, underlain by a yellow fine sand that extends to a depth of more than 3 feet.

This soil is well distributed along the lake front on the Lake Michigan terrace. Its surface is level to gently undulating. In many places it occurs as low, broad ridges with gentle slopes, having their long axes roughly parallel with the shore of the lake. Owing to the loose character of the material the natural drainage is excessive.

Probably 90 per cent of the type is under cultivation and devoted to trucking and light general farming.* The soil is

*For a discussion of the chemical composition and methods for the improvement of this soil see page 55.

deficient in organic matter and nitrogen and low in the mineral plant food elements. It is a soil, however, that responds readily to fertilization, it warms up quickly in the spring, and so is well adapted to the quick growing truck crops, which can be forced to an early maturity.

CHEMICAL COMPOSITION AND IMPROVEMENT OF WAUKESHA FINE SAND AND PLAINFIELD FINE SAND

While these soils occupy only a small proportion of the total area of the two counties in question they are so situated in relation to markets as to be of especial value for the production of truck crops for the cities of Racine and Kenosha, even though they are somewhat lighter in texture than is desirable. Their sandy nature permits them to warm up early in the spring, cultural operations are easy and they respond to fertilization readily. They are therefore utilized largely for the growing of special crops.

The two soils are quite similar in texture and chemical composition except that the Waukesha fine sand has a larger supply of organic matter and nitrogen than the Plainfield fine sand.

From a limited number of analyses made here and in other counties it has been found that in soils of this nature the phosphorus runs between 700 and 900 pounds per acre 8 inches. The potassium runs from 20,000 to 30,000 pounds per acre. The nitrogen of the Plainfield fine sand will average about 1,000 to 1,400 and the Waukesha fine sand will run a little higher.

In the improvement of these soils the first step is to supply the lime which is needed. This will require from 2 to 3 tons of ground limestone per acre. This should be applied to a plowed field and be disced or harrowed into the soil to insure thorough mixing and an intimate contact between the soil grains and the limestone.

The management of these soils to maintain the fertility will depend, to a considerable extent, on the crops grown and on whether or not stock is maintained to which the produce of the farm is fed. When dairying or other livestock farming is practiced it will be less difficult to maintain the supply of the essential elements of plant food—phosphorus, potassium and nitrogen. But even when stock is maintained it is very probable

that the moderate use of some form of phosphorus fertilizers will be found profitable, and some means for increasing the organic matter in addition to the use of stable manure should be made use of as far as practicable. The growth of a crop of soy beans or clover, occasionally, to be plowed under as a green manuring crop, will be found very profitable in its effect on the succeeding crop of corn or grain.

While the larger proportion of these soils are now used for trucking, it is probable that the total area will ultimately be utilized in this way. The use of commercial fertilizers will thus become more common, and a more intensive system be developed. The manure now used is largely purchased, and this practice must continue if manure is to be used. It is becoming more difficult to obtain, however, and so legumes may have to be depended upon more largely than in the past for the source of organic matter, and some of the nitrogen. This when supplemented with mineral fertilizers will maintain the productivity of these lands and insure large yields. In the growing of special crops which are forced, the use of a complete commercial fertilizer is found to be profitable. The various crops require slightly different combinations of plant food in the fertilizers, but the element which predominates is phosphorus. A discussion of the use of commercial fertilizers will be found under the chapter on Agriculture on page 81.

DUNESAND

Dunesand consists of yellowish-brown loose fine sand, passing at 4 or 5 inches into a yellow fine sand of the same general character, extending to a depth of 3 feet or more. In basinlike areas lying between ridges the surface has a dark-gray color, as a result of a larger content of organic matter.

Areas of Dunesand lie immediately along the Lake Michigan shore, between Kenosha and the Illinois state line. It consists of a series of broken ridges extending parallel with the lake. Because of the loose open structure, of the soil and subsoil the drainage is excessive.

Dunesand is extremely droughty and is constantly being shifted by the wind. It is not farmed, but affords a little grazing.

In the northeastern quarter of Sec. 28, Waterford township, is an area consisting in part of Dunesand and in part of Coloma

fine sand. Except in the freshly formed dunes the soil consists of a light brown sand, 5 to 7 inches deep, which grades into pale yellow loose fine sand extending to a depth of 3 feet or more. In a few places the subsoil contains sufficient clay to make it somewhat sticky.

Probably 50 per cent of this area is cultivated, the remainder being covered with scrub oak and used as pasture. The crops grown are corn, oats, rye and hay, but the average yields are low.

CHAPTER V

GROUP OF POORLY DRAINED SOILS

CLYDE CLAY LOAM

Extent and distribution.—The Clyde clay loam is one of the three most extensive soils in Racine and Kenosha counties. It is quite widely distributed, occuring in every township; but its distribution is quite varied in some respects. Throughout the central part of the counties it occurs chiefly as small areas of from a few acres to 80 or 160 acres as depressions in the upland. Along the Des Plaines and Root Rivers farther east it occurs in quite extensive areas tributary to these streams. Along the Lake Michigan terrace it also occurs in tracts of considerable size. They are usually long and narrow. In the extreme western part of the county there is less of this soil than in other portions of the area. In all there are 40,128 acres of this type of land.

Description.—The surface soil of this type to an average depth of 8 or 10 inches consists of a very dark or almost black heavy silt loam, or clay loam, which continues its black color or very dark gray shade to a depth of 12 or 14 inches—the lower portion of this section being a silty clay loam. The surface soil grades into subsoil of dark gray material mottled with brown which usually becomes a lighter gray with depth and at 30 inches is a very calcareous plastic clay mottled with yellow.

There are a number of variations which occur in this soil. Where the type borders Miami soils the surface is somewhat lighter than usual. Bordering some of the peat marshes the surface may be covered with a few inches of decaying vegetable matter making the supply of organic matter higher than typical. Where the soil is associated with Carrington clay loam it often grades into this type very gradually. Throughout the central portions of the region it is associated chiefly with Carrington clay loam and Miami clay loam.

The portion of the type which occurs in the valley of the Desplaines and Root Rivers and tributary to these streams differs

somewhat from the typical clay loam in that there is frequently a layer of sandy material in the deep subsoil. This, however, is usually at a depth below the reach of the auger and seldom comes within three feet of the surface. About 17,000 acres of the type belongs to this phase.

Another phase occurs on the Lake Michigan terrace and represents material which is very similar to the Waukesha soils except the drainage is more deficient. There is also sandy material in the deep subsoil on this terrace phase. The 3-foot section, however, on all of these soils is so nearly identical that all of the low black heavy material has been included in the Clyde series.

Topography and drainage.—The entire area covered by this soil is low and naturally poorly drained. The areas which are associated with the Carrington and Miami soils consist of small depressions in the upland many of which can be drained by the use of a single line of tile. Most of these areas are small being long and narrow as a rule. In origin this material is made up of glacial till and its poor drainage is simply due to its position which is relatively low.

The portion of the type which occurs along the Desplaines and Root Rivers and a few other streams is partly alluvial material and is in part subject to overflow and naturally poorly drained. Some of this material immediately adjoining these streams is difficult to drain until the channel of the stream has been lowered and straightened. These areas are quite extensive and their reclamations frequently require the organization of drainage districts.

The portion of the type occurring on the Lake Michigan terrace is level and low but not quite as low as the type along the streams and its drainage is intermediate between the portion of the type just described and the Waukesha soils. However, over the entire type tile drains are needed before cultivated crops can be grown safely from year to year.

There are two degrees of drainage which were especially noted in the field. Where no tile drains have been installed and where the surface is quite low a marshy condition frequently prevails. Over portions of the type which are somewhat higher or where tile drains have been installed the soil at present can be cultivated successfully and has a somewhat different appearance be-

cause of its improved condition. There is no difference in the soil itself, however, and so all of this material has been classed as the same type.

*Present agricultural development.**—Clyde clay loam is one of the most productive soils of the region when thoroughly drained and cultivated. Probably 60 to 75 per cent of it is under cultivation and most of the remainder is in permanent pasture. Corn, sugar beets, hay and cabbage are important crops. Oats and barley and other grains make a good growth but because of the rank growth of the straw are apt to lodge. The quality of the grain is not equal to that grown on light colored upland soils. Alsike clover and timothy do well on this soil. Hemp to which this soil apparently is well adapted is an important crop in the vicinity of Union Grove. The type is especially well adapted to corn and with the Clyde silt loam probably forms some of the best corn land of the state when drained. On the Lake Michigan terrace practically all of the type is under cultivation and devoted to truck crops. Sugar beets, cabbage, onions, potatoes, tomatoes, carrots, strawberries and beans are among the products grown. Hay, barley and oats are also raised but general farming is of secondary importance on the lake terrace. Along the lake shore large quantities of stable manure are shipped in from the Chicago stock yards; from 15 to 20 tons per acre frequently being used. Some commercial fertilizers are also used especially on the onions, sugar beets and cabbage.

CLYDE SILT LOAM

Extent and distribution.—The Clyde silt loam is one of the important and extensive soil types in Kenosha and Racine counties. It covers a total area of 34,688 acres. In the western part of the area where it is associated with Miami silt loam this soil occurs as rather small areas in depressions in the upland. Tributary to the Desplaines and Root Rivers are found the most extensive areas of this soil. About 27,000 acres out of the 34,000 is located tributary to these streams. About 4,000 acres are distributed over the Lake Michigan terrace in the extreme eastern part of the county.

Description.—The surface soil of the Clyde silt loam is a dark brown or black silt loam very high in organic matter and extend-

*For a discussion of the chemical composition and methods for the improvement of this soil see page 62.

ing to a depth of 12 inches or more. The upper subsoil is a brown or dark silty clay loam and in the lower part below 24 inches a gray clay is found which is often mottled with brown and yellow.

As mapped this type is subject to many variations. Over the lower portions of the type there may be a surface layer of one to six or eight inches which consists of peaty material. Over some portions of the type where there has been considerable surface wash a similar peaty layer is found at a depth of 1 or 2 feet over very limited areas. Out of New Munster and at a number of other places in the western part of the area the surface is a dark colored Marly silt loam which passes at about 14 inches into a gray material which is largely Marl and silt. This continues to a depth of over three feet.

On the broad terraces along Lake Michigan and tributary to the Fox and Desplaines River beds of sand and gravel are in many places present at depths of 18 to 36 inches. The surface soil sometimes carries considerable sand and gravel. In such cases there are many included patches of clay loam. In the eastern part of the township of Summers there are inclusions of superior silt loam. There are also a few places where the texture of the surface soil is a loam instead of a silt loam.

Topography and drainage.—The surface of this type is low or depressed, level and naturally very poorly drained. There are two rather distinct degrees of drainage, one where a condition approaching marsh is found and where the land is entirely too wet for cultivation at present and the other where the soil occupies a slightly higher position or where it has been artificially drained and where cultivated crops can now be grown with a fair degree of safety. The soil in both instances is identical, the only difference being in the condition of drainage. Many times a fence line will form the boundary between such conditions.

In the western part of the area where most of the tracts of the soil are small the land is seldom subject to overflow and can usually be drained with one line of tile. Along the Fox, Root and Desplaines Rivers the areas are much larger in some places, the soil is subject to overflow and drainage must usually be developed cooperatively. The establishment of drainage districts being necessary where the ownership is distributed among sev-

eral farmers. A portion of the land tributary to these streams is of alluvial origin while that in the west part of the county is a part of the glacial till material. Along Lake Michigan the material is part of a terrace formation and is somewhat better drained than other portions of the type.

Present agricultural development.—When drained the Clyde silt loam is probably the best corn soil in Wisconsin. It is also well adapted to a large number of other crops, such as hay, root crops, cabbage, sugar beets and the truck industry is quite highly developed upon it in the eastern part of this area. Much of the land has been tile drained and is now highly improved. Probably 60 per cent of the type is under cultivation. The portion which is in use is chiefly that which is subject to overflow. A portion of the type which is not improved is used largely for pasture. Where general farming is carried on and small grains are grown, lodging is quite common. The grain does not fill out as well and is lighter in weight than grain grown on the light colored upland soils. On the portion of the type occupying the Lake Michigan terrace the soil is devoted chiefly to trucking, sugar beets, cabbage, onions and potatoes being grown. This portion of the type has a higher value than in the central and western parts. The selling price ranging from $250 to $500 per acre where improved. Cabbage yields from 10 to 20 tons per acre, sugar beets from 12 to 30, corn from 35 to 90 bushels, onions about 400 bushels with a range of from 150 to 1,000 bushels per acre. Potatoes yield from 125 to 150 bushels per acre. Commercial fertilizers are used quite extensively and stable manure from the stock yards at Chicago and Milwaukee is also utlfized, though not to as great an extent as in former years because of the increasing price and the difficulty of securing an adequate supply of this fertilizer.

CHEMICAL COMPOSITION AND IMPROVEMENT OF CLYDE CLAY LOAM AND CLYDE SILT LOAM

These two types occupy a total of about 19 per cent of the two counties, and form a substantial part of the best agricultural land in the region. They are characterized by having relatively large amounts of organic matter, accumulated as a result of poor

drainage. The supply of organic matter is quite variable since the soil grades into muck and peat on the one hand and into upland mineral soils on the other. Chemical analysis show that the nitrogen content varies from 4,000 to 10,000 pounds per acre 8 inches. The supply of phosphorus runs from 1,000 to 2,460 pounds per acre while potassium usually runs from 25,000 to 40,000 pounds per acre or more. Where the soil has a thin covering of peat the phosphorus and potassium are present in the surface soil in smaller amounts.

The portion of these soils found on the Lake Michigan terrace usually show some need for lime and ground limestone in such places can be used to advantage. Over most of the region, however, these soils do not need lime. They are so situated that they receive the wash from higher lands, which contain lime material, and this lime-bearing water has prevented the development of an acid condition in these lands. Where acidity is found it is usually so slight that but little if any lime is needed, except as indicated above.

The most important step and the first step in the improvement of these soils is to supply adequate drainage. Many miles of tile drains and some open ditches have been installed and the major portion of the land is now devoted to cultivated crops. Considerable areas, however, are still undrained, and are used chiefly for pasture and hay. The drainage of these lands frequently requires the development of drainage districts, but there are numerous tracts which are so situated that they can be reclaimed by individual efforts.

A condition which sometimes develops on this soil is shown when corn turns yellow on areas of small extent. In such cases the use of some form of potash or strawy horse manure is helpful. There is relatively a much larger supply of nitrogen than phosphorus and potassium. For this reason it is a good practice to use the manure on the upland soils which are deficient in nitrogen and apply mineral fertilizers to the low land when these are needed. In many cases which show a marked need of potassium during the first few years of cropping, usually where the soil is high in organic matter to a depth of a foot, this lack of potassium frequently disappears after a few years of cropping as a result of the settling of the surface so that deep plowing mixes up some of the soil high in potash.

In spite of their large content of both phosphorous and potassium,* it is not infrequently true that these soils show low availability of these elements, especially of potassium. This is probably due to the inert condition of much of the organic matter which protects the earthy part of the soil. Where thoroughly good artificial drainage has been developed and nevertheless poor crops secured, this result will usually be found to be due to lack of available potassium and in some cases also of phosphorus. A direct experiment should be made in these cases with potassium and phosphate fertilizers, as suggested in the bulletins of the experiment station.

These soils are capable with thorough drainage and proper fertilization and cultivation of being made among the most productive lands in the state. Within easy hauling distance of Racine and Kenosha they are being utilized to some extent for trucking, but this industry could be developed to still greater proportions. All of these lands not now being farmed should be drained and put to work, for it is an economic loss to have them idle.

CLYDE FINE SANDY LOAM

The surface soil of this type consists of a dark brown to almost black fine sandy loam, about 10 inches deep. The upper subsoil is a yellowish-brown fine sandy loam, which at about 15 inches passes into a yellow fine sandy loam, fine sand, or a gravelly fine sand. The lower subsoil, from 26 to 36 inches, is a gray fine sandy loam, mottled with yellow, or a bluish drab sandy clay. Included with this type as mapped are small areas of Clyde fine sand and Wabash fine sandy loam.

This is an unimportant soil occurring chiefly along the Fox and Desplaines Rivers and their tributaries. It covers 2,368 acres. The areas have a flat or basinlike surface and poor drainage.

The Clyde fine sandy loam is a water-laid soil deposited largely by stream action. The material comes from glaciated limestone debris but some of the type is in an acid condition.

The native vegetation consists of elm, ash, sycamore, willow, soft maple, alder, and coarse grasses and other water-loving plants.

*For a more thorough discussion of the exact amounts of commercial fertilizers to use, and for methods of application, see the section on the Use of Fertilizers, on page 81. Attention is also directed to the Bulletins of the Wisconsin Experiment Station, which deal with this subject.

Probably 10 per cent of this type is in cultivation; the remainder is used for cutting marsh hay and as a range for cattle. Where open ditches have been constructed and the land drained fair crops of corn, oats and timothy and clover hay can be obtained. Cabbage, onions, and sugar beets should also do well on this type of land where it has been provided with adequate drainage.

Chemical composition and improvmeent.—This soil is somewhat variable in its physical properties. Its supply of nitrogen, phosphorus, and potash is somewhat smaller than in the silt loam, but it contains more organic matter than do the light colored upland soils and contains a fair amount of phosphorus and potash. In its improvement drainage is the first and most important step. When this has been supplied, this soil is well adapted to the growing of general farm crops, but it is also well suited to special truck crops. Where favorably located, it should be devoted to these special truck crops rather than to the growing of general farm crops. When well drained, it warms up readily, is easy to cultivate and therefore very desirable for the growing of crops which require intensive cultivation.

PEAT

Peat areas are most extensive in the vicinity of Powers, Camp, Lily and George Lakes, southwest of Wheatland, north of Brighton, east of Paris, along the state line in the townships of Salem and Brighton, northeast of Burlington, southwest of Caldwell and southeast of Wind Lake. Small beds are scattered throughout the remainder of the area, but are most numerous in the western part.

In the morainic western part of the area the beds occupy old lake basins, ponded valleys, kettle basins, glacial sloughs, and other depressions in the uneven surface developed by the glacial ice sheet. Along the Fox and Desplaines Rivers and tributaries the beds occur mainly in the flood plains.

Peat consists of a black or dark-brown fibrous to rather finely divided vegetable matter mixed with a small proportion of mineral matter, mainly of the grades silt and fine sand. The deposits range in depth from 18 inches to about 20 feet, with an average depth of about 4 feet. Over the greater part of the

deposits the material is fibrous, though in a number of places it is fairly well decomposed, and sticky so that it can be moulded into forms by the hands. When dry this well-decomposed peat somewhat resembles black clay. In regions of sandy soil, the underlying material is usually of a sandy nature, and in regions where heavy upland soils occur the underlying material is heavy in character. Fully 90 per cent of the peat in this survey is underlain by material as heavy as a loam or heavier.

The peat areas are low, level and very poorly drained. During each spring many of the marshes and swamps occupied by the soil are entirely covered with water but during the summer many of the tracts are sufficiently dry and firm to bear the weight of farm animals, so that they can be pastured or where there is a growth of wild grasses cut for hay.

The peat has been formed through the rank growth of vegetation and its partial decay in the presence of water. The black or dark colored material is formed largely from the remains of grasses and sedges, and that having a brown color chiefly from sphagnum moss. About the margin of larger marshes and over the greater part of the smaller ones, varying quantities of soil from the adjoining higher land has been washed in and incorporated with the vegetable matter. Although the peat beds of this area occur within a region where the upland soils are made up in part of limestone material, some of it is in an acid condition. This is usually the case in the center of the large marshes; many of the smaller ones are not acid.

The native vegetation on the peat consists of several varieties of grasses, sedges, arrowhead, cat-tail, various reeds, rushes and sphagnum moss. The amount of tamarack in these two counties is very small, though some of the marshes supported such a growth. Alder and willow also are present in places.

Only a small proportion of the peat of this area has been ditched and reclaimed. Where thoroughly drained, well fertilized, and properly handled such beds in other regions produce good yields of corn, potatoes, onions, celery, sugar beets, cabbage and peppermint. Potatoes grown on peat are not as good as those grown on sandy soils, and small grains are likely to lodge and to be of somewhat lower grade than where grown on upland soils.

Peat, shallow phase.—The shallow phase of peat is essentially the same as the typical soil except in depth of peaty material which is only from 10 to 18 inches instead of several feet.

Areas of this phase are small, but occur in practically every township of Racine and Kenosha counties. They occur around the margin of all the marshes, but usually are so narrow that they cannot be indicated on the map. There are, however, many that consist entirely of the shallow phase.

In topography, drainage, character of vegetation and origin, this phase is similar to typical peat. The methods of improvement and the fertilizer requirements for the first few years after reclamation from the undrained state would be the same as for typical peat, but the material underlying the organic soil is heavy, and where the roots of plants will reach this in their growth the need for potash and phosphate fertilizers is less. When drained the material settles and with but 18 inches or less to begin with, this layer will in time be sufficiently thin to allow the plow to turn up some of the underlying material. Mixing this with the organic layer will greatly increase the value of the land for production and to some extent do away with the need for fertilization.

METHODS OF IMPROVEMENT*

Peat has been largely formed by the accumulation of vegetable matter, particularly sphagnum moss and certain sedges and grasses. It is very low in earthy matter, running from 80 to 95 per cent of organic matter. The amount of the mineral elements is consequently low, the total weight of phosphorus being approximately 600 pounds per acre to a depth of 8 inches, and of potassium, 700 pounds. It will be seen, on comparison of these statements with those made on the composition of such soils as Miami clay and silt loams, that the total amount of potassium, in particular, is extremely small, the amount in peat being often less than 2 per cent of that found in the upland silt and clay loam soils. While the the total amount is small, a large proportion of it is available to plants, especially if the surface has been burnt over, and the supply may be sufficient for from 1 to 3 crops. It is to be expected, therefore, that profitable cropping is possible over a long period of years, only by the use of some form of potassium fertilizer, either barnyard manure, wood

*For a more complete discussion of methods for the improvement of Peat lands see bulletins of the Experiment Station which can be secured free by writing to Wisconsin Experiment Station, Madison, Wis.

ashes, or the usual commercial fertilizers containing this element. The total supply of phosphorus is rather low, though the difference between the amounts present in peat and upland soils is very much less than in the case of potassium. In view of the enormous quantity of nitrogen contained in these soils, the average amount of which is over 15,000 pounds per acre 8 inches, it is unnecessary to use stable manure, the most valuable element of which is the nitrogen, so that, on farms including both peat land and upland soils, the stable manure should be used on the upland, and commercial fertilizer containing phosphorus and potash on the lower land, unless, indeed, there is sufficient manure for the entire farm. These marsh soils are rarely acid on account of the percolation of lime-containing water from higher lands, though occasionally patches of acid peat are found on the larger marshes. This acidity, however, is not so detrimental in the case of marsh lands as in the case of sand and clay soils, since the chief objection to acidity is that it interferes with the growth of those legumes, such as clover and alfalfa, which are needed on higher lands to secure nitrogen but which are not needed on the marsh soils for this purpose, and to the growth of which, indeed, the marsh soils are not physically so well adapted.

In the improvement of peat the question of drainage is the first step to be considered. Both open ditches and tile drains can be utilized in reclaiming the marshy tracts. The major portion of the peat can be profitably drained and improved. When properly handled the peat will produce profitable crops of corn, alsike clover, timothy, and a number of other general farm crops, as well as special crops such as peppermint, celery, etc.

MUCK

The material mapped as muck consists of partly decomposed vegetable matter with which there has been incorporated a considerable quantity of mineral matter. The most common occurrence in the present area is where from 1 to 5 inches of silty material has been deposited over beds of peat. Other areas consist of peat beds that have been drained for a long time, with further decomposition of the fibrous organic matter and a concentration of the mineral constituents sufficient to produce muck. In other places there is a mixture of a marly substance and peat throughout the 3-foot section.

Only a small total area of muck occurs in the survey. Small scattered areas are mapped in all townships bordering Walworth county, and the soil also lies along the bottom lands of the Desplaines River. The areas are low lying and have a level surface, and are naturally poorly drained.

None of the muck is under cultivation at the present time but it is used for pasture and for the production of marsh hay. In places there is a growth of willow, aspen, sumac, ash, soft maple and elm.

When drainage is well established this soil will be well suited to the production of a number of crops. It may be considered somewhat better than peat land, because it is more thoroughly decomposed and also because it contains more mineral matter, and hence larger quantities of the mineral plant food elements. Its improvement can be made along the same lines as suggested for peat but its need for mineral fertilizers is not quite so great. Where suitably located it can be profitably utilized for trucking after being thoroughly drained.

GENESEE LOAM

The Genesee loam forms only a small area in the present survey. It occurs chiefly in the flood plains along the Root River in Caledonia township.

The Genesee loam consists of an upper layer of a brownish gray to brown loam to silt loam, 12 inches thick, resting upon a layer of yellowish gray silty clay loam passing at about 20 inches into a silty clay, mottled with various colors and extending to a depth of 3 feet or more. In some places the lower heavy layer is underlain with beds of sand or gravelly sandy loam. As is likely to be the case with alluvial soils this type is somewhat variable, including small patches of loam, clay loam and fine sandy loam texture. The surface is level and the natural drainage poor. The soil is frequently flooded, and because of this very little of it has been placed under cultivation. With adequate drainage it would be an excellent soil, but this will involve in many cases diking or lowering the bed of the streams, and cost of such work would hardly be justified for the reclamation of this soil at the present time.

DRAINAGE

Racine and Kenosha counties have approximately 104,832 acres of land over which the natural drainage is deficient, according to the classification of the soil survey, and which must be provided with some form of drainage before cultivated crops can be safely grown from year to year. Of this poorly drained land about 25 per cent consists of peat land, while most of the remainder is low, poorly drained land belonging to the Clyde series, with a very small amount in the Genesee series.

The larger proportion of the peat marshes is confined to the western half of the area, while the majority of the poorly drained land other than peat is confined chiefly to the eastern half of the two counties.

The following table, taken from the 1920 census, gives statistics covering the extent to which the development of drainage enterprises have been carried in this region.

DRAINAGE STATISTICS RACINE AND KENOSHA COUNTIES

	Racine County Acres	Kenosha County Acres
All land in operating drainage enterprises	61,847	11,803
Improved land in drainage enterprises	47,205	10,273
Per cent of improved land in farms	32.3	9.2
Open ditches completed—Miles	95.3	14.5
Tile drains completed—Miles	31.7	10.0
Maximum size of tile—Inches in diameter	24.0	30.0
Area drained by open ditches and tile—Acres	54,847	11,763
Capital invested in projects completed	$406,000	$100,100
Acres on which corn was principal crop grown on reclaimed land	39,173	10,249
Total area of land in both counties which is naturally poorly drained	104,832 acres	

As will be noted from this table there are over 70,000 acres of low land in drainage enterprises, and in these there are about 110 miles of open ditch and over 50 miles of tile, the largest of which is 30 inches in diameter.

The types which offer the greatest opportunity for drainage are the soils of the Clyde series. When thoroughly drained these soils make excellent corn land, and they are also well suited to many other special crops such as sugar beets and cabbage. Trucking is carried on to a considerable extent on these soils, and there is room for much more extensive development along this line. On the lighter soils of this series onions are grown quite extensively.

The drainage of the peat land offers opportunity for agricultural development, but the problems in the improving of this type of land are more numerous and difficult than in the case with the Clyde soils. The peats require the use of commercial fertilizers, as indicated elsewhere and special methods of cultivation are also called for, but with proper handling the peat lands can be made to produce profitable crops, and their drainage will add materially to the productive acreage within the two counties. If all the poorly drained land in the area were sufficiently drained so that the gross income would be only $10 per acre there would be added over $1,000,000 to the farmers' income of the two counties each year. Such an important project is worthy of the most careful study by every public spirited citizen of the region. The best results can be secured only through cooperation of all parties concerned.

Where areas of low land include land owned by several people the owners can readily form a drainage district and borrow money on bonds to pay for the improvement. This is the method which has been used, and a number of drainage districts have already been established in this region. In this way the cost can be spread over a period of years, and can actually be paid for from the products of the improved acres. Assistance for the development of such projects can, and in fact must, be secured from the state authorities, who pass upon the feasibility of the project before the courts will permit the organization of a district. Where areas of marsh are small and confined to one farm from which there is an outlet the drainage can be installed without cooperation of neighbors. This has been done in a number of places and small systems of tile drains are not uncommon, yet there are thousands of acres in small tracts which have not been improved, but which would make good productive land when drained.*

*For additional information on drainage see Bulletins of the Wisconsin Experiment Station.

CHAPTER VI

GENERAL AGRICULTURE AND CLIMATE OF RACINE AND KENOSHA COUNTIES

PRESENT STATUS OF AGRICULTURE

The principal form of agriculture in the area at present consists of general farming combined with dairying. The chief crops are corn, oats, barley and hay. Potatoes, wheat, rye and buckwheat are grown to a limited extent. Among the special crops are sugar beets, cabbage and onions.

Corn is the most important crop in the area. In 1909 there were in this crop 50,515 acres, producing 1,923,477 bushels. In 1919 only 23,744 acres with an average yield of 48 bushels in Kenosha and 56 bushels in Racine county, but there is also reported 27,083 acres in silage crops, a distinction not made in the census of 1910, which may be assumed to be almost entirely corn; so that the total acreage in this crop has changed but little if any during the last decade. The Wisconsin No. 8 and the Golden Glow, or Wisconsin No. 12, are the most popular varieties. About 75 per cent of the farms of this area have silos and over 50 per cent of the corn is used for ensilage. Corn is grown most extensively on the prairie soils, though its distribution is quite general over all well drained types.

Hay ranks next to corn in importance, the acreage in tame grasses cut for hay being somewhat larger than for corn. The hay is used almost entirely on the farm for feeding stock.

Of the hay crops a mixture of timothy and clover is the most common. These are usually sown with some small grain as a nurse crop. Medium red clover is the most popular clover.

Alfalfa is becoming an important crop especially in the region where the soils are somewhat gravelly in the western part of the area. The 1919 acreage was 5,576 acres and the production 12,043 tons. Three cuttings are usually obtained annually with an average yield of about 3 tons per acre per season. Alfalfa does well on several of the different types of soil when proper

care has been devoted to the preparation of the seed bed, inoculation, fertilization and the supplying of lime needs. Miami gravelly loam, loam and silt loam are among the soils best adapted to alfalfa.

Considerable difficulty has been experienced in obtaining a good stand of clover, owing apparently partly to winter-killing during the late winter when the snow is melting and the ground freezes and thaws alternately, and partly to the dry weather during the late summer and also to acidity of the soil in places.

With the exception of some of the Clyde and part of the Miami soils a more or less acid condition exists which is detrimental to the best results with clover. The heavy types in the Miami and Carrington series are best for tame hay. Clyde soils also make good hay land when drained. Some alsike clover is grown on the more poorly drained types of soil. Mammoth clover does well on the lighter soils, but on the heavier types it is coarse and not as satisfactory as the medium red. Over the low marshy tracts many tons of marsh hay are cut each year, but this is of inferior quality.

Oats follows the hay in importance and this crop is used mainly for feed on the farm. It is grown most extensively on the medium and heavy soils. In 1919 the wheat acreage was over ten times as great as in 1909. This marked increase is the result of the high prices of the war period. Wheat does best on the heavy, well drained soils. Barley is grown on all heavy soils; with a number of farmers it is the chief cash crop. The acreage is only about one-fourth that of oats. In 1919 there were 1282 acres in rye. In addition to these cereals, a little buckwheat is grown. It is confined largely to sandy soil and rather poorly drained land.

Dairying is the leading agricultural industry and is carried on throughout the area except in the extreme eastern part of the Lake Michigan terrace where the trucking industry has developed. The dairy farmers usually have from six to thirty cows, but the number of larger herds is considerable. The milk is shipped mainly to Chicago and other cities. There are bottling plants at Woodworth, Bristol, Wheatland and Bassetts, a condensary at Burlington, and a malted milk factory at Racine. There are a number of purebred herds in the area. The Holstein breed predominates with Guernsey probably second. There are also some Jersey and Brown Swiss cattle. The

great majority of the dairy cattle is made up of grades, with Holstein and Shorthorn blood predominating. Many of the herds now are headed by purebred sires.

Some steers are shipped into the area from Chicago and from the west for finishing. On a number of farms from 10 to 50 of these animals are fed for several months and then sold for beef.

Hog raising is carried on in all parts of the area. The Poland China, Chester White and Duroc Jersey are the predominating breeds. There are also some of the Berkshire and a few of the Hampshire breeds.

Some farmers raise horses for their own use and there are a few horse breeders who ship out of the area. Clydesdale and Percheron are the leading breeds.

Sheep raising is carried on by a small proportion of the farmers. In the western half of the area where the land is somewhat rolling, the Shropshire is the leading breed. Many sheep are shipped in from the west, fed at Burlington and Trevor, and later sold in Chicago. The manure secured from these feeding activities is an important item as some is used on land in the vicinity. Some, however, is sold to fertilizer concerns and shipped away.

Of the special crops grown potatoes, cabbage, sugar beets and onions are the most important. Cabbage growing is carried on in the eastern half of the area and also in the vicinity of Kansasville, Bristol and Salem. In 1920 the yield from 5,480 acres was 58,437 tons. The crop is shipped mainly to Chicago and Milwaukee. Sugar beets are grown more or less throughout the eastern part of the area and most extensively on the Lake Michigan terrace. They are also grown in the vicinity of Salem, Bristol and Kansasville. Drained Clyde soils are well adapted to this crop although other types are also used to good advantage. The beets are shipped to sugar factories at Janesville, Menomonee Falls and Madison, Wis., and at River Dale, Ill.

According to the 1910 census the acreage of sugar beets in the two counties in 1909 was 1,390 acres, which produced 18,421 tons. In 1919 the acreage was 3,879 and the tonnage was 49,516. It is customary for the farmer to put in the crop and tend to the implement cultivation, while the factory furnishes labor

HARVESTING PICKLING ONIONS

The trucking industry frequently calls for the employment of large amounts of hand labor.

VIEW SHOWING THE HAND CULTIVATION OF ONIONS

This is an important special crop in Kenosha and Racine counties.

to do the hand work, such as thinning, weeding, pulling and topping.

Potatoes are grown on a commercial scale on the Lake Michigan terrace. In other parts of the area, practically all the farmers produce their own supply and many have some for the local markets. The best potatoes are produced in the sandy sections. In 1919, 5,091 acres yielded 217,787 bushels. The Early Rose, Early Ohio, Rural New Yorker and Peerless are among the varieties most commonly grown.

Onions are grown extensively on the Lake Michigan terrace between Kenosha and Racine. About 95 per cent of the crop consists of a variety known as the Red Globe. The product is shipped to all parts of the United States east of the Rocky Mountains. In 1920 there were 580 acres in the two counties.

Commercial gardening is important on the Lake Michigan terrace, most of the produce being sold in Kenosha and Racine or shipped to Chicago and Milwaukee.

Apples are grown in small orchards on many of the farms, but there are few commercial orchards within the area. Very few farmers prune or spray their trees. Strawberries, blackberries, raspberries, currants, plums and grapes are gown to a small extent, chiefly to supply the home. Hemp is a new crop and 400 acres were grown in Racine county in 1920. There is a hemp mill at Union Grove.

METHODS

The tendency throughout the area is toward better and more improved methods of cultivation, the use of fertilizers, and seed selection and as a result of this advance, crop yields are gradually increasing.

Where the land is droughty and not subject to wash fall plowing has been found helpful in the conservation of moisture and in the improvement of tilth. Sometimes the heavy soils are plowed in the fall, usually as much being plowed as labor and weather conditions will permit. It is customary to apply stable manure on land intended for corn. If the land is plowed in the fall, the manure is often hauled out during the winter and scattered over the plowed surface. If not plowed in the fall, the manure is plowed under in the spring. Where stubble land is plowed

in the latter part of the summer, manure is frequently applied before plowing. Throughout the area most of the farmers plan to seed their land to grass at least once every four or five years.

ADAPTATION OF CROPS TO SOILS

Most of the farmers in this region recognize the difference in the adaptation of certain crops and varieties of crops to soils and very many are guided in their general farming operations by such knowledge, but only a few carefully select the crops to which their soils are best adapted. Farmers in general realize that the soils of the Miami series and the Rodman soils when not too rough are best suited to alfalfa. Corn is known to do best on the well-drained and rather heavy types of the Clyde. It also does well on the heavier dark-colored soils of the Carrington and Waukesha series. The Wisconsin No. 8 corn is more suitable for the heavier poorly drained clay loam soils which occur in the eastern half of the county, while the Wisconsin No. 12 is most popular in the western part of the county where the soils are better drained and have lighter texture. The Wisconsin No. 8 requires from 8 to 14 days less time to mature than does the No. 12.

On the dark soils having a large percentage of organic matter small grains are likely to lodge. The quality of the grain is not as good on these soils as on the light colored heavy soils of the county. Potatoes of the best quality are grown on the sandy soils. The sugar content of beets grown on the heavier Carrington, Clyde and Waukesha soils is lower than of those produced on the Miami and Fox soils, but the yield is enough higher on the dark soils to give slightly better net returns.

On the Lake Michigan terrace the light-textured soils of the Fox, Plainfield, Waukesha and Clyde series are the earliest of the truck soils, but the heaviest yields are obtained from the heavier members of some of these series. Cabbage gives the best yields on the Clyde clay loam, silt loam and loam, and on the Carrington soils. Onions do best on the fine sandy loam of the Waukesha and Fox series.

DIVERSIFICATION AND CROP ROTATIONS

It is of great importance in selecting crops to grow that careful consideration be given to the question of climate. This is about the only factor which the farmer absolutely cannot control.

A poor soil may be improved, better markets may be found, and better labor secured; but the farmer is powerless to change climatic conditions. He must, therefore, select such crops as are suited to his climate.

The soil is also a factor of great importance. As a general rule, small grain crops do better on heavy than on light soils, and the same is true of grasses grown for hay. On the other hand, the same variety of corn requires shorter season for maturity on light than on heavy soil. Rather light soils and those of intermediate texture are better adapted to potato growing and root crops. Therefore, on lighter soils the greater acreage should be devoted to cultivated crops than on heavy types.

Shipping and marketing facilities must also be considered in planning a rotation. The farmer located on a sandy loam farm close to a railroad station or home market will often find it profitable to include potatoes in his rotation. If he is located six or seven miles from a station, the profits from growing potatoes will be much lessened. It will then pay him better to raise more corn for stock feeding, and to convert his crops into dairy products which are less bulky, and which for the same bulk have a greater value.

Some of the other things which we should keep in mind regarding a good rotation are that it helps to control weeds. It also aids in controlling plant diseases, and serves to check insect pests. Following a good rotation increases the humus supply in the soil, and insures maintaining a good amount of available nitrogen in the soil. It helps to distribute the labor efficiently throughout the year. A good crop rotation means that the proper crops will be grown at the proper time and in the proper place, and this will aid in keeping the soil in proper sanitary condition. It will also increase net returns from each acre, and improve the general appearance of the farm.

A three-year rotation is very popular on many of the dairy farms. It consists of grain seeded to clover, and the clover followed by corn or some other cultivated crop. Much the larger portion of the corn in this region is cut as silage to be fed to dairy animals. The clover is made into hay, and fed to stock. It is often possible to get two crops of medium red clover in one season. The second crop may be cut for hay or may be pastured. Pasturing is advisable on well-stocked dairy farms. This three-year rotation may be lengthened into a four-year ro-

tation by the addition of timothy so that hay can be cut two years instead of one year, or the land can be pastured the second year instead of cutting for hay.

Potato raising when properly managed is a profitable industry in many parts of the state. Although good crops may be grown on heavy clay soils, the sandy loams are especially well adapted to potato production. For best results, this crop should be grown in rotation with other crops, and should always follow a legume of some kind. Potatoes should not follow corn, or corn potatoes, as both crops draw heavily on the fertility of the land. In the rotations which have been given, potatoes can be planted as one of the cultivated crops. It is better to apply manure to the clover crop rather than just before planting to potatoes, for scab is more common when potatoes are planted on freshly manured land. The three-year rotation just described is excellent for sections where potatoes are grown extensively. As a rule cropping to potatoes oftener than once in three years is not recommended.

The growing of peas for canning is important in some sections, and this crop may be introduced into the rotation very readily. A four-year rotation may consist of small grain, clover, a cultivated crop, followed by peas. This may be made a five-year rotation by adding timothy and cutting hay two years.

The growing of sugar beets is also an important industry, and beets may also be introduced into the rotation without difficulty. It is best not to have the beets follow or precede the corn, but the crop may follow barley or other small grain. Beets may simply take the place of corn in a three or four-year rotation. Cabbage may be substituted for beets without difficulty.

Hemp is coming to be an important crop in Wisconsin. The most satisfactory place in the rotation for this crop is after corn. The corn should have been preceded by clover sod, well manured and plowed in the fall. Hemp may also follow potatoes, cabbage, or any other cultivated crop. Hemp should not follow timothy meadow, bluegrass sod nor pasture in Wisconsin; neither should hemp follow any small grain unless the soil is very well supplied with manure. Hemp will leave the soil in splendid physical condition for any spring sown small grain. It also leaves the land relatively free from weeds, and it is, therefore, a good crop to precede sugar beets, or canning peas. The fol-

lowing rotations with hemp have been found applicable to Wisconsin:

Small spring grain crop (seeded down to clover);
Clover for hay and pasture (manured and fall plowed);
Corn, potatoes or similar crops;
Hemp (then back to small grain and clover).

Another rotation covering three instead of four years is as follows:

Small grain crop (seeded to clover);
Clover (manured and fall plowed);
Hemp (then back to small grain and clover).

LIMING

Racine and Kenosha counties are located within the glaciated limestone region of Wisconsin, and a considerable proportion of the soil forming material has been derived in part at least from limestone. The subsoil of most of the types is well supplied with lime and the surface soil in many places is neutral or only very slightly acid. In fact, many tests have been made where the soil does not show any reaction whatever. The types which are most apt to show acid reaction and which seem to be in need of lime are soils of the Carrington and Waukesha series and Plainfield fine sand. The lighter soils of the Miami series also show slight acidity in places. The peat soils are also slightly acid in places but there is less acidity in the low lands of this region than in the central and northern parts of the state.

The degrees of acidity on any farm may be quite variable. It is quite important therefore that before an expenditure is made for lime that the soil should be tested and the crops observed to determine the actual need for lime.

It should be kept in mind that when a soil is acid according to a laboratory test, it does not necessarily mean that that soil will respond profitably to the use of lime, for acid soils are frequently in need of other plant food elements. The story which the crop tells should be considered. Failure of clover and alfalfa, or a growth of sorrel may be an indication of the need for lime. When there appears to be a medium need for lime, from 2 to 3 tons of finely ground limesetone should be applied per acre. The amount to be used will usually vary with the degree of acidity, the character of the soil and the crops to be grown. Such crops as alfalfa, sweet clover, peas, cabbage, onions, and

lettuce have a high lime requirement. Clover, garden beans, barley, bluegrass, hemp, turnips, and radishes have a medium lime requirement while vetch, white clover, oats, rye, potatoes, sorghum and others have a low requirement for lime.

Ground limestone and marl are doubtless the most economical forms of lime which can be extensively utilized. Lime should be applied the year previous to planting the crop which is to be benefited. It should be applied to plowed land and thoroughly worked in by harrowing. Either fall, winter or spring applications may be made.

The best way to apply lime is with a regular spreader made for this purpose, and there are a number on the market. A manure spreader may also be used by first putting in a thin layer of manure and spreading the limestone evenly on top of the manure. Where several farmers are so situated that they can work together, a lime spreader may be secured jointly for this purpose. The end-gate type of spreader has given good reseults in spreading dry or moist limestone.

After making a first application of two or three tons per acre, it is not likely that another application will be needed for four to six years, and the need should be determined by the story which the crops themselves tell.

It should be remembered that most acid soils are also deficient in available phosphorus, but applying lime will not add to the total amount of phosphorus in the soil. The need of phosphorus* may be so great that but little result will be secured from liming until phosphorus is also added. Frequently the application of phosphorus alone to an acid soil will result in larger increases than the use of lime alone, and for this reason it is important that both deficiencies should be corrected to secure the most economical production.

Several demonstration plots on which lime and phosphate fertilizers were tried out in Kenosha and Racine counties bring out the relation between the needs of lime and phosphorus. In several instances it was observed that where lime alone was applied to Carrington clay loam, for example, that there was no increase in yield, but where acid phosphate was also added a very liberal increase in yield was secured. The acid phosphate when used alone did not give so great an increase. It is ap-

*The question of fertilizers is more fully discussed on page 81.

parent, therefore, that these materials must sometimes be used together, and the only way to determine this accurately is by actual field tests.

COMMERCIAL FERTILIZERS AND MANURES

Analyses of the soils of Racine and Kenosha counties show that much of the land is somewhat deficient in phosphorus. The light colored upland types are low in nitrogen and organic matter, the black prairies are usually somewhat acid and may need limited amounts of lime, and the peat marshes are low in both potash and phosphorus but are usually not acid.

The correction of these defects is a very important problem which cannot be solved except after making a very thorough study of the soils and types of farming followed.

The chemical and physical analyses show that these soils vary greatly in their composition and they also vary greatly in their needs. Some require all three of the most essential elements of plant food to keep up their productivity, while others require only one element. As compared with other soils of the state the land in this region may be considered of very good quality and no more in need of fertilization than the other highly developed agricultural regions of the state. To correct minor defects, however, and to keep up and increase the fertility, certain lines of improvement should be followed.

In supplying fertilizer materials to the soil the most economical sources available should be drawn upon. The supply of stable manure is greater in a dairy region than in a grain raising region, but even here the supply is not always sufficient to meet the needs of the land. In this region a great deal of trucking is carried on and large quantities of manure are shipped in from the Chicago and Milwaukee stock yards. This is used chiefly immediately along the lines of railroad for here long hauls are avoided. The price of this manure is now so high that many feel they cannot afford to use it. Several years ago it could be secured for $20 per car f. o. b., but during the past two seasons the price has reached as high as $70 per car f. o. b.

The readily available plant foods in the form of commercial fertilizers are now being used quite commonly in this region, and in fact these two counties use more than any other two counties in the state. In 1919 there were 1,134 farms report-

ing the use of commercial fertilizer in these counties and for this the sum of $168,425 was expended. This material is used largely on trucking crops. In 1920 there were 580 acres in onions which represents about one-half of the acreage in the entire state. The same year there were 5,193 acres of cabbage, which represents about one-third of the crop of the state. General farm crops are sometimes given applications of commercial fertilizer.

Where general farming is followed and there is a fair to good supply of stable manure the greater part of the nitrogen and potash needed by the crops will be supplied by the manure. When this manure is supplemented by acid phosphate the usual plant food needs of the general farm crops will be provided for. Where a more intensive system of farming is followed, however, and such crops as cabbage or onions are grown there is a much greater need for nitrogen and potash and limited amounts of manure will not fully supply the plant food requirements. Under these conditions the manure should be supplemented with a complete commercial fertilizer rather high in nitrogen and potash.* A 5-8-7 mixture is one which has been used quite commonly by truck farmers. Some are coming to use commercial fertilizers even higher in potash, where trucking is the main type of farming followed.

The analysis of the soil will give some indications as to the need of certain fertilizers, but the growth and behavior of the crop itself will be a more certain guide as to the needs of the soil.

From soil analyses, crop studies, and field tests it has been clearly demonstrated that one element in which many of the soils are deficient is phosphorus. This can best be supplied in the form of acid phosphate, which is readily available, or it may be applied in the more slowly available forms of raw rock phosphate or bone meal. In the trucking region where crops are forced, and where large amounts of readily available plant food must be at hand the complete fertilizers are most commonly used, and applications run as high as 1,000 pounds per acre. Frequently liberal applications of mixed fertilizers are used to supplement stable manure, and it is usually such combinations which produce the largest and most economical yields. In the improvement of the peat marshes in this region potash alone is

*Information on Fertilization of Special Crops may be secured from the Wisconsin Experiment Station.

required first, but after a number of years cultivation it is probable that phosphorus will be needed also. This is especially true of the marshes which do not need lime. Where lime is needed, usually potash and phosphorus are both required.

For general farm crops the usual application of acid phosphate is from 300 to 400 pounds of 16 per cent material per acre when sown broadcast. If applied in the row or hill about half this amount is sufficient. Subsequent applications should be at the rate of about 200 pounds every three or four years thereafter. If treble super-phosphate is used about one-third the above application should be given the land.

The most satisfactory way to apply commercial* fertilizers is with a fertilizer spreader, or with a fertilizer attachment to a grain drill, or planter. If sown broadcast it should be put on the plowed ground, evenly distributed and worked well into the soil. Commercial fertilizers may also be applied by spreading them over the top of a load of manure in the manure spreader. An application should be made at least once during each rotation, and preferably on the small grain crop. When so applied the clover following the grain is benefited and since it makes a better growth it fixes more nitrogen, thus adding to the supply of that element on the farm.

In supplying nitrogen to the soil, the most economical form is through the growth of legumes which may either be fed to stock and the manure applied to the land or the crop itself may be plowed under for green manure.

In order that reliable information concerning the use of fertilizers might be made available for the farmers of this and other sections, the College of Agriculture has undertaken a number of experiments and demonstrations in cooperation with various farmers on several different types of soil.

As many of the soils in the state respond to the use of phosphate fertilizers the results which have been secured with phosphate fertilizers will be of interest in connection with this soil survey report. Most of these tests were made on heavy soils and the results will apply to most of the types in Kenosha and Racine counties.

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*For more information on the use of commercial fertilizers write the Soils Department, University of Wisconsin. Wisconsin Experiment Station Bulletin No. 341 deals especially with the Use of Fertilizers on the Dairy Farm.

Twenty-six trials with oats showed an average yield with phosphate of 58.4 bushels, and without phosphate of 49.8. In several of these cases lime had been applied with the phosphate because the land was being seeded to clover and this lime had the effect of reducing the availability of the phosphate to the oats. Had the lime been applied when the land was put in corn the year previous the influence would have been greater.

In twelve trials with barley, phosphate treatment gave an average yield of 38.5 bushels, while that without the phosphate yielded 32.9.

In seven trials with alfalfa the average yield with phosphate was 4,056 pounds per acre, and without phosphate 3,185 pounds.

In eleven trials with medium red clover the average with phosphate was 3,407 pounds, and without phosphate 2,771 pounds. In the case of both the alfalfa and the clover the phosphate treatment was applied to the previous nurse crop so that the expense of the fertilizer should be divided between the grain and the hay crops.

In four trials with corn, the average yield with phosphate was 47.9, and without phosphate 30.1. One of these fields was on very sandy soil on which the yield with phosphate was 30 bushels to the acre, while without phosphate the yield was only 20 bushels per acre. In another case on what had been originally excellent silt loam soil, the field had been without manure for a number of years and the influence of phosphate was much more marked, having the effect of raising the average effect of phosphorus.

In a single trial on dark silt loam near Dodgeville, the yield of silage with phosphate was 15.8, and without phosphate 8.7.

In six trials with potatoes the average yield with phosphate was 187 bushels, and without phosphate 141 bushels.

In the tests above referred to the treatment used in most instances was 300 pounds per acre of 16 per cent acid phosphate.

A careful study of these experiments shows some interesting results. The results are somewhat variable and not always consistent. Variation may be due in part to variations within the soil, since the types are subject to numerous variations and the plots used were not in all cases composed of soil uniform throughout the test plots. These facts should be kept in mind when the results are being interpreted.

In addition to the above a large number of tests were made on the Kenosha county farm near Pleasant Prairie. Where oats were grown on 20 plots without treatment the average yield per acre was 66 bushels. Where 3 tons of lime were used the average from 3 plots was 66.4 bushels, showing only a slight increase from the use of lime on this heavy Miami soil. Where 3 tons of lime and 400 pounds of acid phosphate were used the yield was at the rate of 78.5 bushels per acre.

As a result of these tests it seems safe to say that the soils tested are in need of both lime and phosphate fertilizer, and the best results are secured when these materials are used together.

Considering the effect of phosphate on oats and clover, it will be seen from 26 trials on oats that the increase due to phosphate was 8.6 bushels of oats, which at 40 cents a bushel, would be worth $3.44, and of 636 pounds of clover, from 11 trials, which at $12.00 a ton would be worth $3.82, making a total of $7.26 increase in value of crop due to an application of about $3.00 worth of acid phosphate. It should be borne in mind, however, that the benefit secured from the application of this phosphate is not limited to the immediate crops of oats and clover. The phosphorus taken up in these crops not only makes better feed but two-thirds of it is left in the manure produced from this feeding and is used over again by the crops grown on the soil to which the manure is applied. In other words, the phosphate applied becomes a part of the revolving fund of soil fertility on the farm. After the first application of 300 pounds of 16 per cent acid phosphate or 100 pounds of treble superphosphate per acre, a general practice of applying 150 pounds of 16 per cent acid phosphate, or 50 pounds of treble superphosphate per acre once in four or five years in the rotation when oats or barley are being sown as a nurse crop for clover or alfalfa, will return the cost of the treatment many fold.

Farmers should distinguish carefully between the phosphate fertilizers containing this much needed element alone, and the so called mixed, or complete fertilizers containing nitrogen and potash, as well as phosphorus, which greatly increases the price of the fertilizer. Nitrogen, which can be secured by the growing of legumes, costs in fertilizer form, 25 to 30 cents a pound, while phosphoric acid, the substance in these fertilizers which contains the phosphorus, costs but 6 cents a pound. One ton of 16 per cent phosphate contains 320 pounds of phosphoric acid and costs

about $20.00 a ton, while a ton of a common complete fertilizer, represented by the formula 4-8-6 and containing only 160 pounds of phosphoric acid, costs about $45.00 a ton on account of the nitrogen and potash it contains, for the purchase of which there is no necessity on the part of the average Wisconsin farmer.

Some of the above fertilizer tests will be continued from year to year and others will be started from time to time. The results secured will doubtless be published in bulletin form when the tests have been completed. Those who desire information concerning the progress of this work can secure specific information by writing to the Soils Department, University of Wisconsin, Madison, Wisconsin.

EQUIPMENT

The farm buildings, including dwellings, are generally large and substantial. The barns are large and usually have a concrete or stone foundation. The silo forms a part of the equipment of most of the dairy farms. The fences are usually good, many of them being of woven wire. The work stock consists of draft horses of medium to heavy weight. The farm machinery in general use includes 2-horse to 4-horse turning plows, smoothing harrows, disk harrows, large riding cultivators, mowing machines, tedders, loaders and binders.

Many farmers have tractors; about 10 per cent of the plowing in the county is done with tractors. Machines for threshing grain travel about the county serving the farmers soon after harvest. Many farmers have their own ensilage cutters, but it is quite common for a number to cooperate in owning such equipment.

LABOR, FARM TENURE AND LAND VALUES

The supply of labor is limited, and the members of the farmer's family do most of the work. Farm laborers are paid from $25 to $75 a month. During haying and harvest day laborers are paid $2.50 to $3.50 per day. Where sugar beets are grown labor is supplied by the factories at a cost to the farmer of about $25 per acre.

In 1919 the number of farms in the area was 3,598 comprising 90.4 per cent of the total land area. The average size of farms is 100.6 acres, of which 73.6 acres or about 74 per cent is improved. The percentage of farms operated by owners is 69.8,

by tenants 27.8 and by managers, slightly over 2 per cent. Where renting on shares is practiced the land owner supplies the work stock, tools, etc., and receives two-thirds of the crop. Where the tenant supplies these in addition to his labor, the land owner receives one-half of the crop. Cash rents range from $4 to $15 an acre, depending upon the location with respect to Racine and Kenosha, transportation facilities, the character of the soil and improvements.

The selling price of the better grades of farm land in the area range from $125 to $400 per acre, the valuation depending upon the quality of the soil, the topography, improvements, distance from markets, railroad transportation, and the condition of the public highways. The highest priced land, excluding locations near cities and towns, consists of the heavy types, and especially the silt loams and clay loams, where the surface ranges from level to gently rolling and where the underdrainage is good. The most rolling land, the sandy loam areas, and poorly drained areas range in value from $50 to $125 an acre, and the deeper sand types, some peat beds, and soils subject to overflow are valued at from $30 to $50 an acre.

AGRICULTURAL HISTORY

The history of the agriculture in Racine and Kenosha counties, Wisconsin, began with the earliest settlement which as already stated was made at the mouth of the Root River in 1835. Rumors of the fertility of the soil of Wisconsin spread rapidly through the older states and started a tide of immigration to the northwest, and within one year from the time that the first cabin was built there were more than one hundred settlers in what is now Racine and Kenosha counties.

The early farming consisted largely of the growing of wheat as a cash crop, and of corn, oats, hay, potatoes and vegetables for subsistence. As more settlers entered the country the growing of wheat was extended into various sections of the area and particularly into the large open prairies and oak openings. About 1845, in the period of more general settlement and farm development, it was reported that the land yielded an average of thirty bushels of wheat per acre. In succeeding years considerable difficulty was experienced in raising wheat on account of blight and in 1862 a reduction of acreage was caused by the

chinch bug. Corn and oats proved to be profitable and the raising and feeding of stock gradually developed into an important industry.

The growing of hops was a very important industry in this region during the sixties and seventies. In 1857 the price of hops was 40 to 50 cents a pound, and in many cases a single crop paid for the land and all improvements. So many went into raising hops, however, that the over-production resulted and in 1869 the price was only 10 to 15 cents a pound, hops of poor quality bringing only 3 cents a pound. The low prices and the hop louse finally caused the complete abandonment of the industry.

Flax was an important crop in the seventies reaching its maximum production in 1879. It continued to be grown extensively until 1887 when the acreage began gradually to decline.

According to the 1880 census, there were 30,386 acres in corn producing 1,180,525 bushels. The oats acreage was 62,670 acres with an output of over one and one-fourth million bushels. There were slightly over 19,000 acres in wheat with a production of 289,000 bushels. The barley acreage was 3,321 acres, rye, 2,375 and hay 81,230 acres.

In addition to these crops 139,438 bushels of flaxseed and 259,180 bushels of potatoes were produced in 1879.

CLIMATE

A considerable part of Kenosha and Racine counties is included within what is known as "The Michigan Shore," which is one of eight climatic provinces in Wisconsin.* This province stretches along the western shore of Lake Michigan and extends inland as far as the influence of the lake modifies the climate to any appreciable extent. This seldom exceeds the width of a county.

The Michigan Shore. The Michigan shore possesses the most equable climate in Wisconsin. The winters are mild (22 degrees), and somewhat moister than elsewhere in the state, resembling those of the coast of Maine, or eastern Michigan; the springs (42 degrees) are retarded and cool, like those along the coasts of New England and British Columbia; the summers (67 degrees) are mild and pleasant, averaging over 2 degrees cooler than the Wisconsin or Rock River Valleys and 4 degrees cooler

*For a more complete discussion of the climate of Wisconsin and its relation to agriculture see Wisconsin Bulletin No. 223.

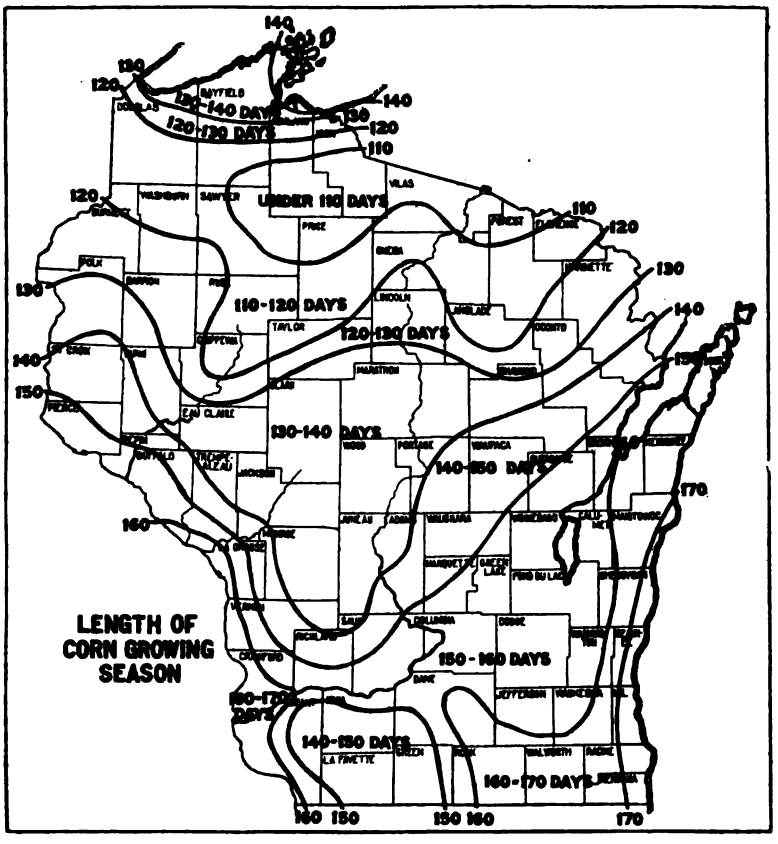

FIGURE II

than the Mississippi Valley; while the autumns (50 degrees) are warmer than farther west, the temperature being about the same as that of eastern Massachusetts, the Hudson Valley, or the Lake Ontario shore of New York. During the winters an average of five days shows a temperature lower than 10 degrees below zero, while on seven days in the year the thermometer registers 90 degrees or more. The lake shore is not a distinctive corn region, but is splendid for pasture, peas, and hay, the growing season extending from about May 1st to October 10th, thus resembling southern Ontario and northwestern New York. The average rainfall (30.3 inches) is slightly less than that of the state in general and a larger proportion is precipitated in winter (5.2 inches) and less in summer (9.6 inches).

The Michigan Shore Province gradually grades into the Rock River basin on the west, and this last named region is the best corn section of the state, while the lake shore country is not especially well adapted to this crop.

This region has a growing season of from 160 to 180 days, which with the Rock River basin has the longest growing season of any part of Wisconsin.

Normal Monthly, Seasonal, and Annual Temperature and Precipitation at Racine, Wisconsin. Elevation of Station 633 Feet Above Sea Level

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Snowfall	Prevailing winds
		Degrees F			Inches	
December	26.0	59	—17	1.39	5.5	NE
January	22.4	60	—24	1.52	9.7	NW
February	22.2	61	—21	1.38	9.2	NW
Winter						
March	34.5	81	— 5	2.35	4.4	NW
April	44.8	83	10	2.47	1.0	NE
May	54.9	96	26	3.55	T	NE
Spring						
June	64.9	102	37	3.08	0	NE
July	71.5	107	45	3.10	0	SE
August	70.7	104	42	2.72	0	NE
Summer						
September	64.2	98	28	3.84	0	NE
October	52.8	88	19	2.56	0.1	SW
November	39.5	74	— 3	1.78	0.5	SW
Fall						
Year	47.4	107	—24	29.74	30.4	NE

Following figures are based on twenty-five year record:
Average date, last killing frost in Spring, April 23d.
Average date, first killing frost in Fall, October 22d.
Latest killing frost in Spring, May 23d.
Earliest killing frost in Fall, September 30th.
Average length of growing season at Racine, Wis., 182 days.

From the table given it will be seen that the mean average temperature for the year at Racine is 47.4 degrees and the average precipitation 29.7 inches. The average snowfall is 30.4 inches. The prevailing wind during the three winter months is from the northwest. The wind during the Spring is mostly from the northeast, as is also true of two of the summer months, while two of the fall months show the wind mostly from the southwest. For the year the average is indicated as being from the northeast.

The average date of the last killing frost in the spring is April 23d and the average date of the first killing frost in the fall is October 22d, giving a growing season at Racine of 182 days free from killing frost. This report is based on records covering twenty-five years.

SUMMARY

This area comprising Racine and Kenosha counties is located in the southeast corner of Wisconsin. It has an area of about 606 square miles.

The topography ranges from level or gently undulating, as on the prairie, terraces and outwash plains, to broken, as in the kame, kettle-basin, and terminal moraine country. The eastern part of the area drains into Lake Michigan and the remainder, through the Fox and Desplaines Rivers, into the Illinois River.

Racine county was established in 1836 and Kenosha county was cut off from it in 1850. Settlement began in 1834. The population of two counties is given in the 1920 census as 130,245 of which 27,554 is classed as rural. The two largest cities, Kenosha and Racine, have populations of 40,472 and 58,953, respectively. These counties are well provided with railroads and public highways. All sections are well settled, the average density of population, 45.0 persons to the square mile.

The climatic conditions are favorable for the development of general farming and dairying. The mean annual temperature as reported at Racine is 47.4 degrees F., and the mean annual precipitation is 29.65 inches. There is a normal growing season for the area of approximately 170 days free from frosts.

The agriculture consists of general farming combined with dairying. A considerable trucking industry has developed in the vicinity of Racine and Kenosha. The common farm crops are corn, oats, barley, clover, timothy, alfalfa, rye and buckwheat. In addition a number of special crops are grown, including cabbage, sugar beets, potatoes and onions.

The sale of dairy products in 1919 amounted to nearly $3,000,000. In addition to dairying, the raising of hogs, and the feeding of beef cattle and feeding of sheep in the western part of the area, are all more or less important.

Land values range from $30 an acre in the sandy and more broken areas to $300 or more an acre in the sections having the best soils and most highly improved farms.

The soils of the area are derived from glacial drift, water-laid materials, and cumulose deposits. Ten distinct soil series, twenty-six soil types, and soil phases, including peat, muck, and dunesand, are recognized and mapped in this area.

The Miami series occurs chiefly in the western part of the area. The material composing the soils of this series consists largely of glacial limestone debris deposited in the form of moraines, kames and eskers. The series as a whole is very well drained. The typical silt loam is rather extensive, and is the leading alfalfa soil of the area. Other general farm crops do well on this soil. The loam and fine sandy loam give fairly good yields of corn, alfalfa, oats and barley. A smoother phase of the Miami series consists of light-colored forested glacial soils carrying some limestone material. The silt loam, deep phase and clay loam occur in large areas and are well adapted to all farm crops common to the region.

The Fox series consists of light-colored forested soils mainly in the glaciated limestone regions. They are derived from outwash plains, deposited as stream terraces, or lake terraces. The silt loam and loam are well adapted to the production of the general farm crops. The gray sandy phase of the silt loam and the gravelly loam are well suited to truck farming.

The Plainfield series consists of light-colored, light textured, terrace soils. With heavy applications of fertilizer they can be used successfully in the production of truck crops. The fine sand was mapped in this area.

The Superior soils occur in only a few small areas, all in Caledonia township. These soils are well adapted to general farming. Clay loam and fine sandy loam were mapped.

The Rodman series includes light-colored forested glaciated limestone soils occuring chiefly in the form of kames, eskers and terrace escarpments. The Rodman gravelly loam is best suited to the growing of alfalfa, to grazing or to woodlots. The areas as a whole are extremely rough and broken and there is but little of this soil under cultivation.

The soils of the Carrington series include dark-colored upland prairie glaciated limestone material. The clay loam and silt loam are extensively developed and constitute some of the best agricultural soils of the state.

The Waukesha series comprises the dark-colored prairie soils derived from reworked glacial material deposited as outwash

plains or terraces. The silt loam constitutes some of the best agricultural land in the area. Corn, oats, wheat, sugar beets and cabbage do very well on this soil. The loam and fine sandy loam are used for general farming and also for trucking. The fine sand is used only for trucking.

The Clyde soils include dark-colored glacial till material occurring in shallow basins and poorly drained depressions. When drained the silt loam and clay loam are among the best soils of the region for corn, sugar beets and cabbage. Two phases of this series in addition to the above were recognized, one includes dark-colored soils that have developed from water laid material within the glaciated limestone region under conditions of poor drainage. They include a silt loam, clay loam and fine sandy loam. The other phase is confined to the dark soils of the Lake Michigan terrace and includes clay loam, loam and silt loams. These soils are devoted largely to trucking. These soils are all so similar in color, texture, average value that in this report they have all been included in the Clyde series.

The Genesee series includes soils derived from the lighter colored materials occupying the flood plains of streams. In the present survey only the loam is mapped. It covers a very small area and is used only for pasture.

Peat consists of vegetable matter in various stages of decomposition, mingled with varying proportions of mineral matter. On well drained, well-fertilized, and properly cultivated areas good yield of corn, timothy and alsike clover (mixed), oats, potatoes, onions, sugar beets and cabbage have been obtained.

Muck is partially decomposed vegetable matter with which there has been incorporated a considerable amount of mineral matter. It contains more mineral matter than peat and has the organic matter in a more advanced stage of decay. Muck is a somewhat better soil than peat. Most crops common to the region can be successfully grown on the reclaimed muck. In Milwaukee county for example the trucking industry is highly developed on similar areas of peat and muck.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

W. O. HOTCHKISS, Director and State Geologist
A. R. WHITSON, In Charge, Division of Soils

SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
H. L. RUSSELL, Dean

BULLETIN NO. 56C SOIL SERIES NO. 30

SOIL SURVEY

OF

WALWORTH COUNTY

WISCONSIN

BY

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SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

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1924

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INTRODUCTION

The State of Wisconsin, working in cooperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the state. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the state, and to be of practical help to farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: First, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity and other physical properties of soil all depend chiefly upon texture, which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil grain surface area to which moisture may adhere.

Texture is determined in the field by rubbing the soil between the thumb and fingers and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a mechanical analysis, which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light-colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.
Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.
Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Very fine sand.—Over 50% very fine sand.

Soils Containing Between 20–50% of Silt and Clay

Sandy loam.—Over 25% fine gravel, coarse and medium sand.
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Sandy clay—Less than 20% silt.

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Sandy loam.—Over 25% fine gravel, coarse and medium sand.

Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Sandy clay—Less than 20% silt.

SOILS CONTAINING MORE THAN 50% OF SILT AND CLAY

Loam.—Less than 20% clay, and less than 50% silt.
Silt loam.—Less than 20% clay, and over 50% silt.
Clay loam.—Between 20 and 30% clay, and less than 50% silt.
Silty clay loam.—Between 20 and 30% clay, and over 50% silt.
Clay—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a graduation in texture of otherwise uniform material, such a group is called a "soil series." It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for example, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel with heavy types predominating. The Plainfield series includes light colored soils in regions where no limestone is present, and where the material occurs at outwashed plains or stream terraces. The soils in this series also have a wide range in texture but sandy types predominate. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey.

By uniting the name of the *soil class*, which refers to texture, with the name of the *soil series*, which refers chiefly to origin, we get the *soil type*, which is the basis or unit of classifying and mapping soils. A *soil type*, thus, is a soil which is uniform throughout its entire extnt in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF WALWORTH COUNTY WISCONSIN

CHAPTER I.

DESCRIPTION OF THE AREA

Location and boundaries: Walworth County is located in the southeastern part of Wisconsin, and its southern border is the Illinois-Wisconsin State line. Its eastern border is about 24 miles from Lake Michigan. Elkhorn, which is the county seat,

FIG. 1—SKETCH MAP SHOWING AREAS SURVEYED

is 71 miles from Madison and 56 miles from Milwaukee. The county is bordered on the north by Jefferson and Waukesha counties, and on the east by Racine and Kenosha counties, and on the south by McHenry and Boone counties, Illinois, and on the west by Rock county, Wisconsin. The county has the

form of a square, measuring 24 miles on each side. It comprises a total land area of 560 square miles or 358,400 acres. The area of the lakes within the county amounts to approximately 14 square miles.

Topography and surface geology: The most important physiographic feature of the county is the series of moraines which mark the different stages of the glacial ice as it advanced and retreated over this region. This county was traversed by the Delavan lobe of the Lake Michigan glacier and by the Green Bay glacier. Where these two great ice sheets came together there was formed what is known as the Kettle Moraine. This begins near the village of Richmond in the westrn part of Walworth county and extends in a northeasterly direction, terminating in Kewaunee county. This kettle range received its name from the numerous holes and pits resembling large kettles. This range is evidently a gigantic moraine, and it forms the main topographic feature of eastern Wisconsin. It ranges in width from 1¼ to 3 miles and is rough and broken throughout its extent. To the southeast of Whitewater it rises about 200 feet above the surrounding country and forms the most conspicuous feature of the landscape. From the village of Richmond extending to the southeast is the Darien moraine which is the terminal moraine of the Lake Michigan glacier. From 3 to 5 miles back from this is the recessional moraine known as the Elkhorn moraine. Extending west from Richmond is the terminal moraine of the Green Bay glacier known as the Johnstown moraine. From 3 to 5 miles north of this range of hills is the Milton moraine. All of these are merged into the Kettle Moraine which was formed by the two great ice sheets.

The Darien moraine is the most important in Walworth county. It has a width of from ½ to 3 miles and varies considerably in the degree of relief shown. Between Richmond and a point opposite the head of Delavan Lake the relief is only from 20 to 40 feet. Near the village of Walworth it reaches 100 feet, and south of Lake Geneva the long slope rises from 100 to 150 feet above the low areas at the south.

By far the greatest relief is found in the slopes of the Lake Geneva basin. In the western part between Cook's Camp and Camp Colli, the lake reaches its greatest depth which is 152 feet. The elevation of the bottom of the lake is 719 feet above

sea level, over 400 feet lower than the crest of the moraine 1½ miles southeast. This makes the highest point about 258 feet higher than the level of the lake.

From Lake Geneva to Burlington the topography is very irregular. The morainic belt is interrupted by depressions with abrupt surrounding slopes. There is frequently a strongly marked knob and kettle topography. Abrupt knolls and ridges of gravel alternate closely with deep rounded pits and narrow winding depressions.

Outside of these morainic regions the ground moraine has a topography ranging from level to gently undulating. In the region of old glacial drift in Sharon township the surface consists of long gentle slopes. The outwash plains to the north and east of this township are level.

Along the streams which traverse the region there are narrow belts of bottom land subject to overflow, and there are also numerous marshes. These are most abundant in the southeastern quarter of the county and in the northern portion.

Elevations: The general elevation of the county ranges from about 822 to 1004 feet above sea level. The following elevations have been indicated along the railroads: Elkhorn, 996 feet, Darien, 943 feet, Delavan, 938 feet, Lake Geneva, 892 feet, Walworth, 1004 feet, Genoa Junction, 845 feet, Whitewater, 822 feet, and Troy, 891 feet. Probably one of the highest points in the county is 1119 feet above sea level. This is the point indicated above, which is south of Lake Geneva.

Underlying rock formations: The greater part of Walworth County is underlain by limestone formations. As shown on the accompanying sketch map of Walworth County there are two kinds of limestone. In the eastern part of the county the uppermost rock and that which is found directly beneath the layer of glacial drift is known as the Niagara limestone. In the western part of the county the uppermost rock is known as the Galena and Trenton limestones. This group of rocks consists of two closely related limestones often considered together as one formation. Between this and the Niagara limestone formations is a narrow belt of Cincinnati shale. These formations have been acted upon by glacial ice and have contributed to a greater or less degree to the formations of the present day soils.

Water Courses: Walworth County lies on a drainage divide, and there are no large streams crossing the county. The drainage of the western part is carried chiefly by Turtle Creek, one branch of which has its chief source in the marshes in Richmond and Sugar Creek townships. Another portion forms the outlet of Delavan Lake. Turtle Creek flows into Rock River at Beloit and then into the Mississippi after traversing Illinois. In the eastern part of the county White

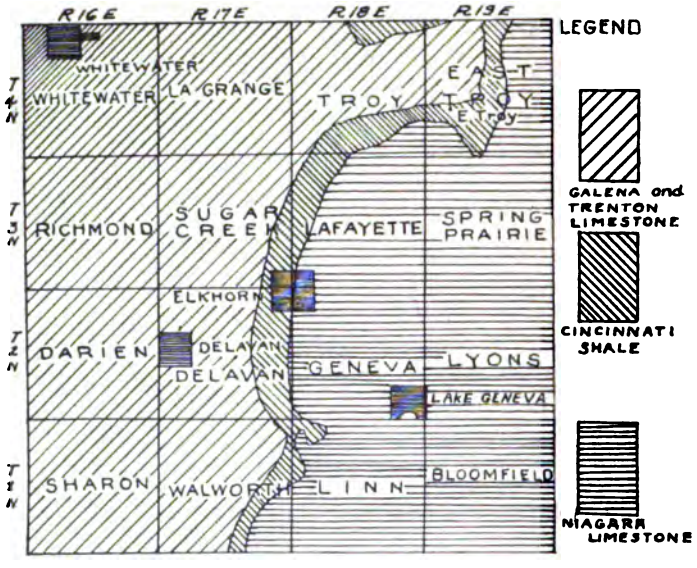


FIG. 2—SKETCH MAP SHOWING THE UNDERLYING ROCK FORMATIONS IN WALWORTH COUNTY

River forms the outlet of Lake Geneva and Lake Como. This stream empties into Fox River at Burlington. Sugar Creek and Honey Creek drain most of the country in the northeastern part of the county and also empty into Fox River. Branches of these various streams form drainage outlets for practically all parts of the county. From a geological standpoint the country is practically new, and streams have not formed deep channels, but are still cutting away their beds. Most of the streams have fairly good fall, and in a few places water power has been developed, but at the present time is not used extensively in any part of the county.

Settlement: The first settlement in Walworth County was made in 1836 in Section 24 town of Spring Prairie. A claim

was staked out at the head of Lake Geneva in 1835 but this was not occupied until later. The county was formed by a territorial act of Wisconsin in 1838 and the county organization began to function in 1839. The early settlers were of Anglo-Saxon descent and came chiefly from New York, Pennsylvania, Illinois, Indiana, and Ohio. Later there was a considerable influx of German, Norwegian, Irish, and English settlers. All parts of the county are now thickly settled and highly developed. The population of the county in 1910 was 29,614. In 1920 the population was 29,327. Elkhorn, the county seat, had a population of 1991 in 1920. Other important towns within the county and their population are: Lake Geneva, 2,632; Delavan, 3016; Whitewater, 3215. Other towns of lesser importance are Sharon, Darien, Walworth, Genoa Junction, Springfield, Lyons, Troy, and East Troy. All of these towns are surrounded by good agricultural country and are distributing points for farm machinery and shipping points for farm produce.

Railways: Walworth County is well supplied with transportation facilities. The Racine and Southwestern Division of the Chicago, Milwaukee and St. Paul crosses the county from east to west, passing through Delavan, Elkhorn, and Springfield. A branch of this line runs north from Elkhorn to Eagle in Waukesha County. The Prairie Du Chien Division of the same road crosses the northwestern part of the county, passing through Whitewater. The main line of the Chicago and Northwestern traverses the extreme southwestern part of the county, passing through Sharon. A branch of this road extends from Chicago to Williams Bay running through Genoa Junction and Lake Geneva. The Milwaukee Electric Light Company has a line extending from Milwaukee southwest to East Troy in this county. Another electric line known as the Chicago, Harvard and Fontana line extends from Harvard, Illinois to Fontana, Wisconsin at the west end of Lake Geneva. These various railroad lines provide adequate transportation for both freight and passenger traffic in all parts of the county.

Highways: Public roads extend into all parts of the county, and most of these are kept in good repair. Under the present system of road development certain roads are being improved as county or state trunk highways. On some of these lines the

roads are constructed of concrete while others are graded and crowned with gravel or crushed rock. A patrol system on all these roads insures their being kept in good repair. These state highways are being supplemented by county highways so that nearly every community is reached by a branch of the improved highway system.

Practically all parts of Walworth County are supplied with rural mail service and also with rural telephones.

Markets: The numerous towns and villages within the county provide a market for a considerable amount of farm produce, but the greater part of the produce is shipped to outside markets, including Milwaukee and Chicago. Numerous shipping organizations have been developed through the work of the Farm Bureau and county agents, and these have resulted in a marked improvement and more profitable handling of live stock and other produce of the farm.

SOILS

The soil material of Walworth County, like that of a considerable area in southeastern Wisconsin, owes its accumulation to several distinct processes, including glacial, alluvial, and possibly loessial. To these may be added the accumulation and decay of vegetable matter and the formation of peat.

The surface of the county as a whole owes its general character to glacial action. Through the action of the ice sheet vast quantities of glacial debris were accumulated, and these were left as the ice sheet melted. Most of the soils of the county have been derived from this glacial debris. As the swollen streams carried quantities of this material away from the glacial ice fields, alluvial deposits were formed. In many of the depressions and partly filled valleys large quantities of organic matter gradually accumulated through the growth and decay of water-loving plants, giving rise to the formation of peat soils. Over a considerable part of the county there is an extremely silty surface soil, which by some authorities is considered to be of loessial or wind-blown origin.

The glaciation which covered most of Walworth County is known as the late Wisconsin. Sharon Town, in the extreme southwestern corner of the county, was not covered by this

glaciation but appears to have been influenced by a much older ice sheet. The few stones and bowlders in this region are more thoroughly decomposed and the drainage ways more thoroughly established than in the region of more recent drift in other parts of the county.

In this county there is a marked variation in the depth of glacial drift over the underlying rock formations. From various well records the depth of the drift has been determined in a number of places. At Richmond the depth is about 230 feet; at Elkhorn, 213 feet; at Yerkes Observatory, 405 feet; and at Delavan, 439 feet. In LaGrange and Sugar Creek Towns the records of five wells, chiefly from the outwash plains, show that bedrock was reached at a depth of 230 to 235 feet. This variation in depth is accounted for by the presence of a preglacial valley extending across the county. In this valley the till in places is over 200 feet deeper than elsewhere. In Sharon Town the depth of the drift is variable also, although this is in the region of the older glaciation. A number of rock outcrops occur, while on the other hand the depth extends locally to 200 or 250 feet. Very little of this region has a shallow mantle of glacial material over the rock. Ninety per cent or more of the gravel found in the drift consists of limestone material. Mixed with this, however, are varying proportions of crystalline rock gravel. In the morainic areas the material carries a very high percentage of stone, gravel, and bowlders, and in deep cuts some rough stratification can be seen. The ground moraine areas or till plains are less stony and a large proportion of the stones present are angular or subangular, showing that they have not been transported for any great distance. The outwash plains and terraces consist of stratified beds of sand and gravel mantled with a thin layer of sandy or silty material.

Probably for a long time after the glacial period there was very little forest growth on any of the lands of the county. Marsh and prairie conditions became well established in time. Later tree growth took possession of the areas where conditions were least favorable for maintaining a heavy sod of grasses, as in the rougher morainic and sandy areas. As time went on the forest encroached more and more upon the prairie areas of the smoother till plains and along streams and slopes until a large percentage of the upland and terraces were

covered with a medium to heavy tree growth. In the main the timber growth held to the better drained areas, but some of the wet lands became forested, including the overflow lands along the streams and the swampy depressions where deep peat deposits have accumulated. As found by the early settlers, the forest areas with fair to good drainage were supporting a scattering to dense growth of hardwood consisting mainly of oak, maple, and hickory, and on less well drained areas oak and hickory, with some ash, elm, and soft maple. Some of the areas of peat had a dense growth of tamarack or a mixture of alder and willow with scattering tamarack. Prairie grasses thrived over the open lands, except the low-lying flats and depressions that were in a condition of true marsh.

The soils of the Walworth County have resulted from the changes brought about by weathering of the several classes of material laid down during and since glacial times. Naturally they are quite varied in their color and other characteristics. The soils developed under forest cover where fair to good natural drainage has been established are light in color, characterized by gray to brown surface soils and gray and brown mottled to yellow and reddish-brown subsoils. The weathered zone extends to a depth of 2 to 3 feet in the more recent glacial areas, and to 4 feet or more in the old glaciation in the southwestern corner of the county; and enough leaching has taken place to remove all free carbonates, the surface soils being in an acid condition. The soils that have developed under prairie conditions vary from black surface soils over mottled yellow and gray subsoils in the poorer drained area to dark-brown surface soils over yellowish-brown evenly oxidized subsoils in the best drained areas. As with the light-colored soils, all free carbonates have been leached from the weathered zone, which extends to depths ranging from 2 to 4 feet, and in most areas the surface soil shows at least a slight acid reaction. The marsh and swamp soils are characteristically black or very dark brown over gray to bluish-gray and yellowish brown mottled subsoils; or, in the case of the organic soils, they have a black mucky to brown peaty character to depths of 1 to 3 feet or more. The soils developed in the marshy areas generally are not in an acid condition, although as a rule they contain very little if any free carbonate, except in the substratum.

Taking into account the different processes by which the

soil-forming material was accumulated and the different physiographic positions occupied, the soils may be arranged in four main groups: (1) soils of the uplands derived from ice-laid deposits; (2) soils of the terraces and outwash areas derived from old water-laid sediments; (3) soils of the flood plains consisting of recent alluvium; and (4) soils from organic remains or peaty accumulations. In the first two groups the soils may be divided into light and dark soils. For the purpose of mapping, the soils are classified into series and types. Each soil series consists of soil types that have a comman origin and are similar in color, structure, topography, and drainage. The types in a series differ from each other in the texture of the soil.

The light-colored soils developed under fair to good conditions of drainage in the uplands are classed in the Miami series, except the very gravelly, kamey areas classed in the Rodman series and the light sandy areas in the Coloma series. The light-colored terrace soils include a corresponding range of conditions which give the Fox and Plainfield series. The Fox soils correspond in color to the Miami soils.

In the dark upland group the soils developed under good drainage conditions belong to the Carrington series, and under poor drainage, to the Clyde series. In the terrace or old sedimentary group the Waukesha and Clyde series represent the well-drained and poorly drained soils respectively. The Clyde series includes dark depressions in the upland as well as some poorly drained terrace soils. All of the recent alluvium is classed in the Genesee series, although the Wabash series is represented to a small extent. The organic soils are mapped as Peat.

The surface soils in the Miami series are grayish brown to brown, and the subsoil is reddish brown or yellowish brown in the upper part and reddish brown below. The subsoil is heavier than the soil, and rather compact and tough. At a depth of 2 to 2½ feet it passes into a lighter, more friable material, this being stony and gravelly till only slightly weathered and carrying a high percentage of limestone material. In this series the surface soils are neutral or only slightly acid. The surface is undulating to strongly rolling and rough, and drainage is well established.

In the deep phase of Miami series the surface soils are brownish gray to grayish brown, and the subsoil is yellowish brown

and usually shows some rusty iron streakings and specks. The subsoil is heavy and tough to a depth of 36 to 48 inches, grading below into a more friable material which is moderately to strongly calcareous. The surface soils are in an acid condition. The topography is undulating to gently rolling, and the drainage is fairly good, but slower and not so perfect as with the typical Miami. The level phase of the silt loam has rather imperfect drainage.

The Coloma series is characterized by grayish-brown surface soils and a yellowish-brown light sandy subsoil. The unweathered parent material below depths of 2½ to 3 feet usually is light and sandy and carries little or no limestone material. The surface is undulating to strongly rolling, and the natural drainage is good to excessive.

The Rodman series is developed on the very gravelly parts of the moraines with very irregular and broken topography and the rougher parts of the terraces, where a shallow layer of brown soil has formed over the loose gravel deposits. The drainage is excessive.

The Fox series has grayish-brown to brown surface soils and a yellowish-brown to slightly reddish brown subsoils, heavier than the soils in texture and somewhat compact and tough in structure, resting upon stratified beds of gravel and sand at depth of 20 to 48 inches. The substratum contains a high percentage of limestone material. The surface soil is in an acid condition. The topography is level to gently undulating, and the drainage is good.

The surface soils in the Carrington series are dark brown to black and the subsoil is yellowish brown to brown. The subsoil is somewhat heavier and more compact than the soil to a depth of 24 to 48 inches, giving way below to moderately friable calcareous till like that underlying the Miami series. All free carbonates have been removed from the soil section, and the surface layer gives an acid reaction. The topography is gently rolling, and the natural drainage is good.

The types of the Plainfield series have grayish-brown sandy surface soils and a yellowish-brown sandy subsoil and substratum. The surface soils are in an acid condition, and no free carbonates occur in the soil section. The surface is level to undulating. The drainage is good to excessive.

The types of the Waukesha series correspond in their profile characteristics to those of the Carrington series except that the substratum beginning at depth of 24 to 48 inches is more distinctly sandy and gravelly, consisting of stratified beds of calcareous sand and gravel. The topography is level, and is characteristic of the smoother terraces and outwash plains.

The surface soils in the Clyde series are black, and the subsoil is gray to bluish gray mottled with yellow and yellowish-brown. The subsoil is a little heavier than the soil in texture, but is generally plastic in the heavier types, becoming more friable in the unweathered material reached at depths of 30 to 40 inches. The substratum of the Clyde soils is calcareous glacial debris like that under the Miami and Carrington series. The surface soils are not acid. The Clyde soils occur in flat and depressed areas in the uplands where a marshy or semiswampy condition existed. The Clyde series also includes dark poorly drained terrace soils having some sandy layers in the subsoil but of practically the same agricultural value.

The Genesee series includes brown to nearly black soils with gray mottled subsoils. They occur in alluvial plains of streams and are subject to frequent overflows. Small areas of light-colored soils were included. Both Genesee and Wabash soils were included in this classification. The type is quite variable.

The organic soils mapped as Peat range from black and finely divided to brown and coarsely fibrous.

Approximate are of different soils

	Acres	Per cent
Miami silt loam	81,024	36.3
Miami silt loam deep phase	39,552	
Miami silt loam level phase	9,856	
Clyde silt loam	41,280	11.5
Waukesha silt loam	3,200	9.2
Waukesha silt loam, deep phase	29,696	
Peat	28,032	8.1
Peat Shallow Phase	1,216	
Miami loam	3,136	7.2
Miami loam, gravelly phase	22,464	

Carrington silt loam	24,256	6.8
Fox loam	2,624	6.9
Fox silt loam, deep phase	18,746	
Fox lom	2,624	2.5
Fox loam, gravelly phase	6,272	
Rodman gravelly loam	7,232	2.0
Clyde clay loam	6,528	1.8
Fox fine sandy loam	3,648	1.0
Miami fine sandy loam	3,456	1.0
Genesee silt loam	6,976	1.9
Carrington loam	950	.9
Carrington loam, gravelly phase	2,048	
Waukesha loam	1,792	.7
Waukesha loam, gravelly phase	896	
Clyde loam	2,176	.6
Coloma fine sand	1,792	.5
Miami stony loam	1,664	.5
Plainfield fine sand	1,408	.5
Total	358,400	

CHAPTER II.

GROUP OF HEAVY SOILS

Miami Silt Loam

Extent and distribution: The Miami silt loam with its several phases covers 130,420 acres or 36.1 per cent of the area and it is the most extensive and important type of soil in Walworth County. It is widely distributed and is found in every town in the county. The portion of the type considered as the typical Miami silt loam is described first and this is followed by a description of the two phases which are shown on the soil map. The typical soil covers 81,024 acres, the deep phase covers 39,552 acres, and the level phase 9,856 acres. The largest areas of the typical soil are found in the towns of Lima, Geneva, Spring Prairie, and La Fayette. The Miami silt loam is associated with a wide range of other upland soils and its continuity is also frequently broken by areas of low lying poorly drained soils.

Description: The surface soil of the Miami silt loam is a grayish-brown mellow silt loam 6 to 8 inches deep. This is underlain by material of about the same texture and a slightly yellowish brown color which in places changes to a slightly reddish brown material and extends to a depth of 12 to 18 inches. Below this depth it gives way to the subsoil proper, which is a reddish-brown compact silty clay loam grading at a depth of 18 to 24 inches into a friable gravilly or gritty loam or clay loam. Locally the material below 30 inches is rather gravelly, but the gravel is almost always mixed with considerable clay so that the subsoil is retentive of moisture. The subsoil of this type differs from the subsoil of the Miami silt loam deep phase in containing considerably more sandy and gravelly material, in having a more crumbly structure, and in being more thoroughly oxidized. The supply of organic matter in the surface soil is rather low, which accounts for the light color.

The surface soil is slightly gravelly in places and locally

contains some fine sand. The depth of the surface soil also varies somewhat with the irregularities in topography, and on many slopes the surface has been sufficiently eroded so that the reddish-brown subsoil is exposed. These reddish-brown spots are characteristics of the Miami silt loam, and are common in many cultivated fields. Some crystalline rock bowlders occur on the surface and through the soil section, but as a rule they are not present in sufficient numbers to interfere with cultural operations. Where they were originally most numerous they have in most cases been removed from the fields.

Included with the typical soil and shown on the soil map by the same color is a phase which differs somewhat from the typical soil. It is a gray to grayish-brown silt loam 8 to 10 inches deep underlain by a yellow or mottled gray and yellow compact silt loam or silty clay loam which passes at a depth of 18 to 24 inches into a brown or reddish brown compact gritty clay loam. At about 30 inches or more the subsoil usually changes to gravelly sandy clay or gravelly sandy loam. This variation from the typical soil was found most extensively in the vicinity of Elkhorn in the towns of Lafayette Sugar, Creek, Delavan and Geneva. It is here associated with the Miami silt loam deep phase and level phase and occupies slight knolls and swells. The surface is undulating to very gently rolling. The drainage is better than on the level phase but not as good as on the typical soil. The material forming this variation has practically the same origin as the typical soil and the deep subsoil is calcareous. The surface soil in places shows some acidity.

Topography and drainage: The surface ranges from undulating to gently rolling, and in some places it is rolling and slightly hilly. Owing to the uneven surface and the open character of the subsoil, the natural drainage is good. Water moves through the soil section freely, but there is sufficient clay present to make the soil retentive of moisture. Some of the type is subject to erosion, as indicated by the exposure of the subsoil on knolls and slopes and the formation of small, shallow gulleys. Where the wash from the slopes has accumulated along the lower slopes, the soil is considerably deeper than the average.

Origin: This type has been derived from glaciated limestone material ground from the underlying limestone. With this has been mixed a small proportion of material from the region of crystalline rocks farther north as evidenced by the small content of granitic gravel and stones. Although the material is mainly from limestone, the surface soil has been leached to a considerable extent and in many places is now in an acid condition. The deep subsoil, however, still contains considerable lime carbonate.

Native vegetation: The original forest growth consisted of several varieties of oak, hickory, and maple. Most of the merchantable timber has been removed, but there are still a few wood lots that contain saw timber. If properly conserved, these wood lots would furnish fuel for the use of farmers for a long time.

Present agricultural development: The Miami silt loam is one of the most important soils of Walworth County, and nearly all of it is included in highly improved farms. It is a good general farming soil and all of the general crops grown in the region are produced on this type. Corn, oats, barley, wheat, and hay are the most important crops. Sugar beets are raised to a considerable extent, and canning peas are grown successfully. This soil is probably better adapted to alfalfa than any other of the extensive types in the county, and a large majority of the alfalfa fields are located upon this type. This is doubtless due to the open character of the subsoil and to the fact that there is generally considerable lime in the deep subsoil.

The crop rotation most commonly followed consists of small grains, hay, and corn. The small grains are seeded with alfalfa or clover and timothy. Hay is usually cut for 1 and sometimes 2 years, then the land is broken, planted to corn, which generally occupies the land for one year, although on some farms it is grown for 2 years. The available manure is usually applied to sod before plowing for corn. When alfalfa is grown it occupies the land for 3 to 5 years, or as long as the stand is satisfactory.

Miami Silt Loam, Deep Phase

Extent and distribution: The Miami silt loam, deep phase, is found in several portions of the county, though in most

places it does not occupy areas of more than 5 or 6 square miles in one body. Some of the more important areas are in the northeastern part of Walworth Town, in the central part of Geneva Town, and in LaFayette, Richmond, Lima, and Sugar Creek Towns. This phase in the older glacial area occupies about 70 per cent of Sharon Town and extends over into the western part of Walworth Town. This is by far the most extensive development of the phase. This phase covers a total area of 39,532 acres.

Description: The surface soil of the Miami silt loam, deep phase, in its typical development consists of a brownish-gray, smooth, friable silt loam extending to a depth of from 10 to 12 inches, and becoming somewhat lighter in color in the lower part. The soil is remarkably free from gravel and coarse material, and very few bowlders occur on this type. The subsoil is a slightly yellowish brown silt loam passing at about 14 or 16 inches into a compact yellowish-brown or light-brown, smooth, compact silty clay loam. This extends to a depth of 36 inches, where it grades into a more porous, gritty, calcareous till, which is somewhat gravelly in places.

The surface soil is uniform in texture but varies slightly in color owing to the large accumulation of organic matter on some of the nearly level or slightly depressed areas. There is also some variation in the depth of the soil section over gravelly till. This may range from about 20 inches to 4 feet, with an average of about 3 feet. The areas where the depth to gravelly calcareous material ranges from 20 to 30 inches are similar to the typical Miami silt loam, but are too limited in extent to map out.

The large areas of the phase in Sharon Township are in the old glaciation. Here the surface soil to a depth of 8 to 10 inches consists of a brownish-gray, smooth, friable silt loam, rather low in organic matter. When dry the surface material has an ashen appearance. The surface is entirely free from gravel, only an occasional bowlder is found and the soil section contains very little sand. The upper subsoil consists of a yellowish silt loam which becomes heavier and grades into a silty clay loam at a depth of 14 to 16 inches, and this in turn becomes a silty clay at about 2 feet. At a depth of 3 feet or more the subsoil shows a slight mottling or streaking with rusty iron stains. The sub-soil is heavy, and compact, and

rather tough, and is almost entirely free from sandy and gravelly material. The tough silty clay loam to silty clay subsoil extends to a depth of 4 to 6 feet where it passes abruptly into unassorted gravelly sandy material. This gravelly material contains much lime, but it is less calcareous than the substratum of the typical Miami silt loam. Tests indicate that the entire soil section form the surface down to the gravelly material has varying degrees of acidity. The contents of organic matter varies slightly, being greatest along the bottoms of slopes and in slight depressions.

Topography and drainage: The surface is very gently undulating to gently rolling, and most of the slopes are long and smooth. As a rule the natural surface drainage is good. In a few places, however, where the surface is nearly level, tile drain can be established to advantage, and on a number of the gentle slopes tile drainge would be beneficial because of the heavy character of the subsoil.

The slopes along some of the stream courses in the old glacial area are more abrupt than typical. This variation is of limited extent and minor importance. It varies considerably from the typical soil.

Gravelly material comes closer to the surface in places and gravel is frequently found on the surface. In places erosion has removed surface soil and cut gullies in some of the hillsides.

Origin: This soil has been derived from glaciated limestone material. The portion found in the southwestern part of the county represents an old stage of glaciation, while the remainder was formed from the late Wisconsin drift. Over much of both of these glacial deposits there is an extremely silty covering which may be in part of wind-blown origin. The gravelly till material beneath the soil section in the deep subsoil contains considerable lime but the upper part of the soil section is usually somewhat acid.

Native vegetation: The native timber growth on this soil consisted chiefly of oak, maple, hickory, with some elm and cherry. Most of the trees suitable for saw timber have been cut but there is sufficient left in farm wood lots to supply fuel for farm use for a long time.

Present agricultural development: Practically all of this type is included in farms, and nearly all of it is highly develop-

ed. It is an excellent soil, and a good seed bed can usually be prepared without difficulty. The yields average well with those on the prairie land. The chief crops grown are corn, small grain, hay, sugar beets, and peas for canning. The large areas in Sharon Town are devoted chiefly to general farming and dairying and the chief crops are corn, small grains, and clover.

Barnyard manure is the only fertilizer generally used, although recent tests indicate that the soil responds well to commercial fertilizers containing phosphorus, as the soil is somewhat deficient in this element. Small amounts of nitrogen combined with the phosphorus also give excellent results. The crop rotation most commonly followed consists of small grain seeded to clover and timothy. Hay is cut for 1 or 2 years, and sometimes the land is pastured for one season before it is plowed for corn. Corn may be raised for 1 or 2 years, when the land is again sown to small grain.

Miami Silt Loam, Level Phase

The level phase of the silt loam is most extensive in the vicinity of Elkhorn. It occurs chiefly in the towns of Lafayette, Sugar Creek, Delavan, and Geneva. None of the areas are large, but in this region they are rather numerous and make up from 20 to 25 per cent of the total area of certain sections. The area covered by this soil amounts to 9856 acres.

Description: The surface soil of this phase is a mellow gray silt loam, about 8 inches deep, the lower part of which may be somewhat mottled. Below this depth it grades through 3 or 4 inches of yellowish or mottled yellow and gray silty clay loam into a subsoil of mottled yellow, plastic silty clay. The subsoil becomes strongly mottled with increasing depth, showing drab, gray, red, and yellowish mottlings below 24 inches and soft concretions of dark-brown iron-bearing material. The lower subsoil becomes decidedly plastic and impervious. Mottled gravelly sandy clay or sandy loam is found locally in the lower part of the 3-foot section, but the presence of this material does not appear to improve internal drainage to any marked extent.

The deep subsoil is quite calcareous.

A variation from this phase was found and included with the level phase and is shown on the map by the same color. It is confined largely to the town of Sharon in the southwestern

part of the county. Here it occurs chiefly as a gradation from the deep phase of the Miami silt loam to the areas of Clyde silt loam. The surface is flat or very gently sloping and the natural drainage is deficient. It varies from the level phase by being somewhat darker in color, more strongly mottled in the subsoil and somewhat deeper to calcareous material. The variation is cold and wet in the spring and usually late in warming up. The material has about the same origin as the deep phase of the Miami silt loam.

Topography and Drainage: The surface is flat or very gently undulating and the soil occupies a position intermediate between the Miami silt loam and soils of the Clyde series. In many low spots small areas of Clyde silt loam are surrounded by this soil. Because of its position and its heavy subsoil, the type has deficient natural drainage and it is cold, wet, and backward in the spring.

Origin: The material forming this soil has been derived chiefly from late Wisconsin glaciated limestone till, the same as most of the Miami silt loam, deep phase. Leaching has not been carried to as great an extent, however, and the lower part of this soil is highly calcareous.

Present Agricultural Development: All of the level phase is included in farms, and part of it is devoted to the raising of general farm crops. Yields, however, are rather uncertain and usually low. Because of its backward condition and rather poor drainage, the type is devoted chiefly to hay and pasture. The native growth on this soil consists chiefly of hickory, oak, some ash, and soft maple. This soil generally does not constitute entire farms and usually is associated with some higher lying, better drained land; it is therefore not difficult to utilize it in its present condition, since it supplies good pasture for the greater part of the year.

Fox Silt Loam

Extent and Distribution: The Fox silt loam occurs in small areas, in 14 of the 16 towns in the county, mainly, however, in the northern half of the area. The largest single area is in sections 17 and 20 in the town of Troy. The typical soil of this type covers an area of 6,016 acres, while the deep phase covers 17,536 acres and a poorly drained variation covers 1,216

acres additional. In all, the Fox silt loam with all its variations covers 6.7% of the entire county.

Description: The surface soil of the Fox silt loam consists of about 10 inches of light-brown floury silt loam which becomes a grayish brown when thoroughly dry. This grades through several inches of yellowish-brown or buff, compact silt loam into yellowish-brown silty clay at a depth of from 12 to 14 inches. This material is uniform and is comparatively free from coarse particles. Stratified sand and gravel is generally encountered at depths ranging from 18 to 36 inches.

Topography and Drainage: The surface of this type is flat or very slightly undulating. Pot holes and terrace slopes form variations in the topography in a few places. On some slopes the surface soil has been removed by erosion, thereby exposing the heavier subsurface material, which accounts for the soils being heavier on these slopes than elsewhere. In places the gravelly subsoil is also exposed on these slopes. The underlying coarse material insures good drainage.

Origin: The type is derived mainly from limestone material ground up by glacial ice and modified to some extent by the action of water. It occurs on outwash plains or stream terraces deposited in their present position largely by the action of streams coming from beneath the glacier. The deep subsoil contains considerable limestone gravel but from the surface this lime has been mostly leached and the soil is now slightly acid in places.

Native Vegetation: The native forest growth on this land consisted chiefly of maple, oak, some hickory and various other hardwoods. Nearly all of this timber has been removed and this land placed under cultivation and is now in highly improved farms.

Present Agricultural Development: This soil can be classed with the types of the highest agricultural value in the county. The chief crops grown are corn, oats, barley, clover and timothy, with a gradually increasing acreage of alfalfa.

The gravelly material in the subsoil is calcareous, but the surface soil in places has become leached to a great extent and acidity has developed. This acidity is seldom strong, and in many places alfalfa can be grown without the use of lime. However, tests should be made on each field before alfalfa is grown, and lime applied where needed.

The methods of farming on this type are practically the same as on the Miami silt loam.

Fox silt loam, deep phase: Fox silt loam, deep phase, has an average depth of 12 inches and consists of a gray to brownish-gray floury silt loam. This grades through a zone of 3 to 6 inches of compact silt loam into a compact yellowish-brown silty clay, which continues without change to a depth of over 3 feet. Stratified sand and gravel are generally encountered at depths of 40 to 60 inches, but are seldom reached within the 3-foot soil section.

There are some minor variations in the soil, chiefly around potholes where the surface soil is somewhat more loamy than typical and not quite so deep. Around some of these places gravel occurs in small quantities on the surface.

The Fox silt loam, deep phase, is confined almost entirely to the north half of the county and occupies a total area of approximately 17,536 acres. The largest tracts occur in Richmond, La Grange, Troy, and East Troy Towns. The village of Troy Center is situated on an area of about 2 square miles of this soil.

The surface is for the most part level, but locally it is somewhat irregular from the presence of kettle basins and potholes. In some places these are sufficiently numerous to give the phase a slightly rolling topography. Because of the underlying sand and gravel, the drainage is usually fair to good, but where the heavy layer is deepest the drainage is slightly deficient, and in such places a slight mottling may occur in the lower subsoil.

This soil has been derived from glacial material, chiefly from ground-up limestone which was deposited in the form of outwash plains or stream terraces. The deep subsoil is not acid, but the surface soil in places has developed a slight degree of acidity.

The phase was originally in forest consisting chiefly of maple, hickory, and oak. Most of it has been cleared and placed under cultivation and is now in highly improved farms. It may be classed as one of the important agricultural soils of the county. It is devoted chiefly to general farming and dairying, and the principal crops are corn, small grains, clover, and alfalfa. The system of farming is practically the same as on the Miami soils, and the yields are very similar. Farms on this soil have a selling value of $150 to $200 an acre.

The surface soil of a variation in the deep phase consists to a depth of 6 to 8 inches of dull-gray, friable silt loam. The subsoil is a light-gray, whitish, or mottled yellow silt loam, passing at 12 to 18 inches into plastic, mottled, gray or yellow silty clay, which at a depth of about 3 feet grades into calcareous stratified material or into mottled gray or yellow calcareous silt loam.

This variation is confined almost entirely to the northern half of the county and is most extensive in the towns of Troy, Sugar Creek, and Richmond. Two of the largest areas are in sections 6, 7, and 8 of Richmond Town. None of the areas exceed one-fourth of a square mile in extent, and many of them cover only a few acres. The poorly drained variation is associated chiefly with the typical soils of the Fox series and it covers a total area of 1,216 acres.

Included with the variation are some areas of loam, in which the surface is a gray or light brown loam, about 8 or 10 inches deep, underlain by a subsoil of light-gray or slightly mottled yellow and gray sandy loam or loam, which changes at 18 to 24 inches to a compact impervious sandy or silty clay. Beds of stratified sand and gravel are reached at a depth of 36 inches or more. The loam occurs in the northern half of the county in patches of a few acres to forty acres. It is associated with the Fox series and may be considered as being a poorly drained variation in the Fox loam. In places it is associated with Clyde silt loam, but is lighter colored than the Clyde and occupies a slightly higher elevation on outwash plains. The surface is level or nearly level, and the natural drainage is deficient.

The surface of the variation is level and is slightly lower than the typical Fox soils with which it is associated. Because of this slightly lower position and the heavy nature of the subsoil, the drainage is somewhat deficient. The chief difference between this and the typical Fox silt loam is that it has poorer drainage, and consequently a strong mottling in the subsoil.

The original forest growth on the poorly drained area consisted chiefly of elm, soft maple, hickory, and some oak. Most of the merchantable timber has been removed, but there are a few scattering trees in places.

Most of the soil is under the plow and used for corn, hay,

and small grains. The part not cultivated is mainly in permanent pasture or meadow. The soil is rather cold and wet in the spring and becomes dry and hard in the early part of the summer. It is quick to show the effects of a dry spell, since the water does not move freely through the compact subsoil. Crop yields are somewhat lower than on the typical Fox soils. Better drainage is usually the most important need.

Carrington Silt Loam

Extent and distribution: The Carrington silt loam is one of the important and extensive types in Walworth County, covering over 24,000 acres. It occurs in rather large areas in several localities. A considerable prairie in the southern part of Spring Prairie Town, extends over into the eastern part of Lafayette Town. A second prairie region is in Delavan Town, and a third in Linn and Bloomfield Towns. Other smaller tracts of the type occur in various parts of the county.

Description: The surface soil of the Carrington silt loam consists of a dark-brown to a black silt loam which grades into a chocolate-brown silt loam and extends to a depth of 10 to 14 inches. It has a large supply of organic matter, is smooth and friable in structure, and contains very little material as coarse as a fine sand. The subsoil consists of a brown or yellowish-brown silty clay loam which becomes somewhat heavier with depth and in places lighter in color at about 2 feet. The lower subsoil is generally a clay or silty clay loam and grades at 30 to 36 inches into yellowish-brown gravelly sandy clay or gravelly clay loam. In many places there is a sharp line between the extremely silty material and that which contains coarser particles of sand and gravel. The areas of section 6 of Sharon Town and section 3 of Darien Town differ from the typical in having greater depth to the calcareous substratum, being about 4 feet. These areas are in the old glaciation.

There is some variation in the soil. On some of the slopes and knolls the color is lighter than typical, being more brown than black, the soil may be somewhat loamy and slightly gravelly, and the underlying gravelly clay material is nearer the surface than typical. This variation is due to the partial removal of the surface soil by erosion. Along the lower parts of slopes there are local accumulations of wash from the higher

land, and as a result the soil is somewhat deeper than usual and may contain more organic matter than typical. Such variations, however, are of small extent, and the slopes that are subject to destructive erosion are not numerous on this type.

Topography and drainage: The surface ranges from level or nearly level to gently rolling. The natural surface drainage is adequate and the water moves through the soil in a satisfactory manner, but the drainage can hardly be considered rapid. In fact there are a few places with nearly level surface where tile drains would be beneficial.

Origin: The Carrington silt loam has been formed mainly from limestone material worked up by the most recent glaciation. The extremely silty covering of the type may be due to the presence of wind-blown material deposited over the unassorted glacial debris. The large content of organic matter in the soil is due to the growth and decay of a rank prairie vegetation. The gritty lower subsoil contains considerable limestone material in the form of small pebbles, but the surface material has been leached to such an extent that practically all of the lime carbonate has been removed and the soil is now acid. The degree of acidity is somewhat variable, but all portions of the type show some acidity. The gravelly portion of the deep subsoil is quite calcareous, containing a considerable amount of lime rock fragments.

The portion of the type in the southwestern part of the county has been formed largely through the action of glacial ice of a much greater age than that which acted upon the remainder of the county. This portion of the type has therefore been subjected to a longer period of weathering and it is more thoroughly leached than is the material derived from the more recent glacial drift.

Native vegetation: This is a prairie soil and the native vegetation consisted largely of prairie grasses, with a fringe of timber along the water courses and bordering other types.

Present agricultural development: Carrington silt loam is one of the most highly prized agricultural soils in Walworth County. Probably 95 per cent of the type is in improved farms and is highly developed. It is devoted to dairying and general farming, corn being one of the most important crops. The most common rotation consists of corn for 2 years, followed by small

Peas are grown to some extent in Walworth county. This is a view of a viner. These are located in the pea growing sections and greatly reduce the hauling distance from the fields in which the peas are grown. The vines are stacked and later fed to stock.

View showing level surface typical of the Fox and Waukesha soils.

grain, usually for 2 years, when the land is seeded to clover and timothy. Hay is cut for 1 or 2 years before the land is again plowed for corn. Stable manure is usually applied to the corn ground. Because of the extremely silty nature of the soil, it works up readily into a mellow seed bed. The difficulty experienced in getting satisfactory stands of clover is attributed chiefly to the acid condition of the soil.

Waukesha Silt Loam

Extent and distribution: The typical Waukesha silt loam is not extensive. The largest tract occurs in the town of Spring Prairie. Smaller patches are found in Troy, East Troy, and Walworth Towns. Most of these areas are small, and many of them consist of long narrow belts in slight depressions or on gentle slopes. It covers a total area of 3,200 acres. The deep phase, described later, is much more extensive.

Description: The surface soil of the Waukesha silt loam consists of dark-brown to black silt loam grading below 6 or 8 inches into chocolate-brown compact silt loam which extends to a depth of 8 to 12 inches. The subsoil is light-brown silty clay, grading into a gritty silty clay or compact sandy clay. At depths of 24 to 36 inches this passes abruptly into beds of sand and gravel. The soil for the most part is uniform, but in a few places the surface soil contains more fine and medium sand than typical. The depth to the sand and gravel is variable, but is seldom less than 18 inches. Where it is 3 feet or more the land has been classed with the deep phase of Waukesha silt loam.

Topography and drainage: The typical Waukesha silt loam occurs as outwash plains or stream terraces. The surface is level or very gently undulating. Because of gravel and sand in the lower subsoil, the natural drainage is good. In places the type occurs on the border of potholes or on terrace slopes. In such cases the soil is usually lighter in color than typical, and because of erosion there may be some gravel on the surface. In a few places the type occurs in long, narrow, shallow depressions through which water flows during wet seasons.

Origin: The material forming the type has been derived in part from glaciated limestone material which has been reworked by the action of water. The beds of gravel are largely of limestone material, and the lower part is not acid. The sur-

face of the soil, which is extremely silty, may be in part of windblown origin. Its dark color is due to the accumulation of organic matter. This surface has been thoroughly leached and is now in an acid condition.

Native vegetation: The type is practically all prairie land and the native vegetation was largely prairie grasses. There was frequently a fringe of timber along some of the water courses and bordering other types of soil but by far the greater portion of the type was treeless.

Present agricultural development: Waukesha silt loam is classed with the land of high agricultural value in Walworth County. The type is almost entirely under cultivation and included in highly improved farms. It is used for the production of corn, small grains, hay, and some special crops. Potatoes are grown to a considerable extent on the area in Spring Prairie Town, and some onions are also grown with success. Because of the underlying beds of gravel and sand, the type is somewhat better drained than the deep phase and can usually be worked a little earlier. When the need for lime is supplied, alfalfa gives satisfactory yields and is gradually being grown more extensively on this soil. The use of lime is the first and most important step in the improvement of this type. Phospate fertilizers give excellent results and can be used with profit on all crops.

Waukesha Silt Loam, deep phase: The surface soil of Waukesha silt loam, deep phase, consists of 10 to 14 inches of dark-brown to a black silt loam. The subsoil is a deep-brown or chocolate-brown silty clay loam, which becomes heavier and more compact with depth until at 24 inches it generally is a yellowish-brown silty clay. At about 30 inches some gritty material occurs in places in the subsoil and at depths of 40 to 60 inches beds of sand and gravel are reached. The phase as a whole is uniform, except for a slight variation in depth to the sand and gravel and a slight mottling here and there in the lower subsoil.

The deep phase of Waukesha silt loam has a total area of approximately 29,000 acres and with the typical soil it covers 9.3 of the county. It is an important soil in Walworth County. It occurs chiefly in three areas, one in Walworth Town, one in Darien and Richmond Towns, and one in LaGrange and Sugar Creek Towns. A number of smaller patches are scattered

throughout the western half of the county. Comparatively little of this phase occurs in the eastern half of the county.

The surface of the Waukesha silt loam, deep phase, is level or only slightly undulating. Because of the deep heavy soil material and the level surface, the natural drainage, while fair, is not quite as free as that of the typical soil. In some localities tile drains might be beneficial, especially where the soil is deepest over the underlying sand and gravel.

The material forming this type was deposited by water as terraces or outwash plains. The gravelly substratum was derived largely from the underlying limestone but the extremely silty surface covering may in part be wind-blown. The dark color is due to the accumulation of organic matter under a native vegetation consisting chiefly of prairie grasses. The deep subsoil is calcareous but the lime has been leached from the surface soil and practically all of the type is more or less acid and needs lime.

The Waukesha silt loam, deep phase, is one of the most highly prized soils of Walworth County, and includes some of the finest farms in the region. The leading crops are corn, small grains, and hay. Corn is one of the most important crops and does better on this soil than on most of the other soils in the county. The small grains yield well, but usually the quality of the grain is not so good as that raised on the light-colored upland soils. Sugar beets are also grown with good results. Alfalfa can be successfully raised if the soil is limed, and the acreage is gradually increasing. Corn yields from 40 to 70 bushels per acre; oats, 50 to 65 bushels; barley, 35 to 50 bushels; timothy and clover, 1½ to 2 tons of hay; and sugar beets, 13 to 18 tons per acre. Other special crops grown are cabbage, which yields 12 to 14 tons; potatoes, which yield from 125 to 200 bushels; and tobacco, with yields ranging from 1,000 to 1,600 pounds per acre. Tobacco is usually grown on the same field for years, and most of the manure is applied to the tobacco patch at the expense of the rest of the farm.

Chemical Composition and Improvement of Heavy Soils in Walworth County

These soils are very similar in the texture, and structure of the surface and the upper portion of the subsoil section. They differ chiefly in color. The Waukesha and Carrington silt

loams are dark colored prairie soils, and both are high in organic matter and nitrogen. Miami and Fox silt loams are light colored and are timbered soils low in organic matter. The types are so closely related that with few exceptions methods for the improvement of one will apply to the others.

The four elements of plant food with which the farmer is most concerned in his farming operations, and the ones which are the most apt to be deficient are nitrogen, phosphorus, potassium and lime or calcium. He should know the part which each plays in the development of the plant, and what are the best methods of maintaining an adequate supply in the soil.

The soil has been leaching for a large number of years, and has lost much of the lime which it may have contained. Varying degrees of acidity have developed over the entire region. The loss of lime from the soil is caused by two distinct factors, both of which are important. Crops require lime in their growth. A 5 ton crop of alfalfa requires 185 pounds of lime and 2 tons of red clover removes 61.6 pounds. A much larger amount is removed by leaching each year and these losses must be made up by the application of lime in order to maintain the fertility of this soil.

Tests show that the subsoil, especially of the deep phase of Miami silt loam is frequently deficient in lime to a depth of thirty-two inches or more. The deficiency frequently extends down to where fine gravel and coarse sand is found in the subsoil.

While it will be seen from tests that by far the greater part of this land shows some degrees of acidity it does not mean that all the land is in immediate need of lime. Where such crops as alfalfa, sugarbeets, tobacco, peas, cabbage and other garden crops are grown and where the acidity is medium from 2 to 3 tons per acre of ground limestone may be used with profit. Where a liberal supply of manure is available the need for lime will not be so great. The second application which may be needed after 4 or 5 years will be less than the first.

Where such crops as corn, clover and oats are grown with manure once during each rotation a smaller amount of lime will be needed. On parts of the farm where manure cannot be applied the lime can be used with profit on such soils and may be actually necessary for economic production. The

greater need will usually be on the higher places, rather than on the lower slopes.

It has been quite definitely established that the need for lime in these soils runs practically parallel with the need of phosphorus. The use of lime alone will not make enough phosphorus available, and the use of a phosphate fertilizer will not supply the lime requirements of the soil. Either lime alone or acid phosphate alone will give increased yields, but neither alone will give as great an increase nor as profitable an increase as when both are supplied. In the improvement of these lands, therefore, provision for the use of both lime and a phosphate fertilizer should be made.

Phosphorus exists in all soils in small amounts. Many of the best types in the state contain only 1,200 pounds to the acre eight inches deep, and this is in a form which becomes available to crops very slowly. Phosphorus is constantly being lost from the farm in crops, milk and in the bones of animals sold. It is well understood that when grain, hay, potatoes or other cash crops are sold, this element is removed from the farm. This element cannot be supplied from the air and in the long run the loss must be made up through additions of phosphorus fertilizer in some form.

Ten samples of Waukesha silt loam from Southeastern Wisconsin gave an average of 1,408 pounds of phosphorus per acre. In 16 samples of Miami silt loam the average amount of phosphorus present was 1,057 pounds per acre. The lowest amount found in any of the samples was 800 pounds per acre. The number of pounds of phosphorus in the soil however, cannot be taken to indicate the immediate need for phosphate fertilizer. The system of farming followed, crops grown, type of soil, and conditions relative to the need for lime are all important factors in determining the need for phosphorus. It should also be borne in mind that where soils are acid the amount of phosphorus which they do contain is not so readily available to plants as in soils which are not acid.

On good upland soil where dairying or general farming is practiced the use of 200-300 pounds of 16 per cent acid phosphate or 75-100 pounds of 44 per cent super-phosphate to the acre every four or five years will maintain the phosphorus supply. If much grain, potatoes or other crops are sold, more phosphate should be used.

On a farm at Elkhorn in Walworth County an application of one hundred pounds per acre of treble superphosphate (44 per cent) on corn gave a yield of 15,570 pounds of silage while on the untreated plot the yield was 13,335 pounds per acre. In a test on the Station Farm at Madison, on the Miami silt loam soil a phosphate fertilizer applied at the rate of two hundred pounds per acre on oats gave a yield of 93.8 bushels while the untreated yield was 70.4 bushels. This was on land where the fertility was quite high. In another case where 500 lbs. of 16 per cent acid phosphate per acre was applied to prairie land which received both manure and limestone the yield of alfalfa was nearly doubled. In some of these cases the increase is small but it should be kept in mind that the fertilizer left over in the soil will be of considerable value to the following crop, especially clover.

On soils relatively low in fertility somewhat more phosphate should be used at first. This is especially true of the dark prairie soils which have grown corn or small grain a long time without the use of manure or other fertilizer.

If considerable amounts of bran or cottonseed meal are fed, which are relatively high in phosphorus, the supply of this element may be maintained. It would usually be necessary to feed at least one-half ton of bran or cottonseed meal to each cow on a dairy farm per year to maintain the phosphorus supply of the soil. Since comparatively few farmers do that some phosphate fertilizer should be used.

Potassium exists in these soils in large amounts, but in relatively unavailable form. Chemical analyses show that they often contain from 30,000 to 40,000 pounds an acre eight inches, while these same soils will contain only one-eighteenth as much phosphorus. On most soils of fairly heavy texture, when live stock is maintained, and the manure carefully used so there is considerable actively decomposing organic matter in the soil, a sufficient amount of potassium will become available from year to year to supply the needs of general farm crops. There are some crops that need relatively large amounts of potassium such as potatoes, tobacco and cabbage and they will often be benefited by some addition of potash in the form of commercial fertilizer.

Nitrogen is chiefly responsible for the dark green, healthy color and rapid growth of corn or other crops on well manured

The difference in the growth of corn in this view is due to the fact that one side of the field received the drainage from a barn yard near and is thus fertilized with liquid manure, while the other side of the field received no fertilizer. Usually the drainage water from the barn yard is lost.

Barn yard with concrete retaining wall which is used to help conserve the barn yard manure.

land. It is important to have sufficient amounts in the soil, but when in excess it is detrimental for some crops. The quality of the grain may be injured by too much nitrogen. When the grain lodges the kernels do not fully mature.

Virgin soils contain large amounts of nitrogen but if they are cropped continuously to such crops as corn, oats and timothy without the addition of fertilizer material containing nitrogen the nitrogen supply is gradually used and the yields are reduced.

The supply of organic matter and nitrogen in the prairie soils is considerably higher than in the light colored timber soils. Eight soils tested from the Waukesha silt loam contained an average of 4,500 pounds of nitrogen in the surface eight inches per acre. Carrington silt loam will average about the same. This amount is considered a very good supply. A question of importance in connection with the nitrogen of this soil, however, is its availability to plants, and in the soils which have been under cultivation for a long number of years, this nitrogen is somewhat inert, and when in this condition, decaying vegetable matter, green crops, or manure plowed under will give a more readily available supply of nitrogen.

The clover, alfalfa, peas and beans have bacteria on their roots that take the free nitrogen from the air and store it in the plant roots. This is the cheapest method of obtaining nitrogen and one which the farmers should use to the fullest extent. On the ordinary dairy farm at least one-fourth of the land under cultivation should be seeded to clover or alfalfa. This should be fed to stock or plowed under as green manure to insure keeping up the supply of nitrogen and organic matter.

A rotation with a legume plowed under will secure nitrogen and reduce danger from diseases, and when supplemented with phosphorus and potassium fertilizers the legumes thus treated will take the place of manure, which can then be used for other crops on the farm.

Certain crops such as tobacco, potatoes and vegetables are grown by farmers who do not keep much livestock and who do not rotate these crops with legumes. This is not a good practice. See chapter on Agriculture for more information on farm practices and types of farming.

CHAPTER III.

GROUP OF LOAMS AND FINE SANDY LOAMS

MIAMI LOAM

Extent and distribution: The typical Miami loam is confined chiefly to the towns of East Troy, Troy, and Lyons, although some patches occur in other parts of the county. Only a few areas contain more than a quarter section, and the total area covers 31,136 acres. The gravelly phase of this type is much more extensive than the typical soil. The gravelly phase covers 22,464 acres which makes a total of 7.2% of the county covered by the Miami loam and its gravelly phase.

Description: The surface soil of the Miami loam consists of a brown or light grayish friable loam extending to a depth of 6 to 8 inches. This is underlain by material of about the same texture and somewhat lighter color. At 14 to 18 inches this material passes into reddish-brown sandy clay or gritty clay loam, which rests upon gravelly till at a depth of 24 inches or more.

The type is somewhat variable and the texture of the surface may range from a heavy sandy loam to a light silty loam. The subsoil is looser and more open than the subsoil of the silt loam and is also more variable, in places containing considerable sandy material. However, it contains enough clay to make it retentive of moisture.

Topography and drainage: The surface ranges from undulating to strongly rolling, with numerous knolls and ridges. Some of the slopes are rather steep, but the most of the type would be classed as gently rolling. Because of the surface features and the open structure of the subsoil the type is well drained. The steeper slopes are somewhat subject to erosion, but not more so than on the Miami silt loam.

Origin: This soil has been derived from glacial material ground largely from the underlying limestone by glacial ice. The subsoil contains much lime carbonate, chiefly in the form

of small pebbles and powdered rock, but the surface soil has been leached to a large extent and over a considerable part of the type an acid condition has developed. The degree of acidity ranges from slight to medium according to the Truog test. There are numerous places where tests show no acidity at all.

Present agricultural development: The type originally was in forest, chiefly of oak, hickory, and maple. By far the greater part is under cultivation and is used for a wide range of crops, including corn, oats, barley, rye, soy beans, clover, alfalfa and timothy. Clover and alfalfa have been more uniformly successful on this type than on most other soils of the county. This is due chiefly to the fact that the soil contains considerable lime carbonate and is also well drained. The system of farming followed, including crop rotation, cultivation, and fertilization, is practically the same as on the Miami silt loam.

Miami loam, gravelly phase: The gravelly phase of the Miami loam varies in texture. It is mainly a brown gravelly loam with a deep-brown or reddish-brown, tough, gritty clay loam subsoil, which carries considerable gravel and passes at depths of 18 to 24 inches into gravelly or somewhat sandy calcareous till. The texture of the surface soil ranges from a gravelly sandy loam to a gravelly silt loam, and in some places where the surface has been eroded the exposed surface is a gravelly clay loam. A few small areas that are practically gravel free are included with the type.

The Miami loam, gravelly phase, is found in every town in the county. The smallest area is in Sharon Town, and the most extensive occurrence in Richmond, Sugar Creek, and Lafayette Towns. The surface ranges from rolling to broken and hilly, and in places the slopes are rather abrupt. Over most of the type, however, modern farm machinery can be used. Because of the uneven surface features and the loose character of the subsoil, the natural drainage is good and sometimes excessive.

The material forming this soil was worked up chiefly from the underlying rock by glacial ice and formed into terminal and recessional moraines. The type contains a very large proportion of limestone material, and the subsoil is very high in carbonates. The surface soil is seldom acid and for this reason is well suited to the growing of clover and alfalfa.

The native timber consisted chiefly of oak and hickory. There

are still a number of wood lots remaining, but most of the merchantable timber has been cut.

The greater part of this type is in improved farms, but considerable areas are kept for permanent pasture because of the uneven surface and rather steep slopes. Where it is farmed the general farm crops of the region are grown. These include corn, small grain, and hay. Alfalfa is grown on this soil and does very well because of the large content of lime. The rotation and methods of cultivation followed are similar to those practiced on the Miami silt loam. Care should be taken to keep the steep slopes covered with growing crops as much as possible, and where there is danger of erosion the land should be kept in permanent pasture.

Miami Fine Sandy Loam

Extent and distribution: The Miami fine sandy loam is confined chiefly to the northern row of towns. It is of rather limited extent, occupying a total of about 5 square miles. It is closely associated with other soils of the Miami and Fox series, and usually occurs in small irregular tracts.

Description: The Miami fine sandy loam has a surface soil of brown or brownish-gray fine sandy loam extending to a depth of 8 to 10 inches. This is underlain by material of about the same texture, although somewhat lighter in color, which grades at 18 to 24 inches into reddish-brown loam, sandy clay, or clay loam. The lower subsoil is generally more or less gravelly below 30 inches. The type as a whole is somewhat variable but none of the variations were found to be of sufficient extent to warrant making a phase on the map.

Topography and drainage: The type occurs chiefly on knolls, drumlins, and slopes and the surface ranges from gently sloping to rolling and in some places hilly. Because of the surface features and gritty subsoil the natural drainage is good.

Origin: This soil has been derived from glaciated limestone material which still contains considerable lime. The surface soil has been leached to some extent and in places is in an acid condition.

Present agricultural develpoment: The original forest consisted chiefly of oak and maple. The crops grown most extensively at present are rye, oats, barley, clover, and alfalfa.

Soy beans and potatoes and some peas and melons are raised. Cucumbers are grown as a special crop in some localities.

This soil warms up early in the spring, is easy to cultivate responds well to fertilizers, and is considered a fair soil. It is better adapted to truck crops than to general farming, however, and where situated so that transportation is satisfactory, it should be devoted to this line of farming.

FOX LOAM

Extent and distribution: The Fox loam occurs in small areas rather widely distributed in East Troy, Troy, and LaGrange Towns. The typical soil covers 2,624 acres and the gravelly phase described under this same type name covers 6,272 acres. Taken all together the type, with the phase included, covers 2.5% of the county.

Description: The Fox loam consists of about 8 inches of grayish-brown loam, underlain by light-brown to yellowish-brown loam, which changes at about 18 inches to a compact yellowish-brown clay loam. Stratified sand and gravel generally occur at a depth of 24 to 30 inches. The surface soil is somewhat variable and ranges in texture from silt loam to fine sandy loam. Wherever these variations were extensive enough they were separated and mapped with the type to which they belong.

Topography and drainage: The surface is level or very gently undulating, except in a few places where it is gently rolling, owing chiefly to potholes and terrace slopes. Because of the underlying coarse material, the drainage is good.

Origin: The Fox loam is an alluvial soil and was practically all deposited by water action in the form of outwash plains or stream terraces. The parent material was largely limestone but because of the action of water much of the lime has been leached out and the surface soil is sometimes found to be acid. The deep subsoil however, is usually calcareous and contains lime.

Present agricultural development: Practically all of the Fox loam is cleared and under cultivation and included in improved loams. The uncleared land is in forest, chiefly of maple, oak and hickory. The chief crops grown are corn, oats, rye, clover, and timothy. Alfalfa also does well on this soil because the underlying material contains much limestone. The methods of cultivation, fertilization, crop rotation followed are practically

the same as on the Fox silt loam, and the methods for the improvement of that type will apply equally well to this soil.

Fox loam, gravelly phase: The Fox loam, gravelly phase, is rather variable in texture, but is consistently gravelly both on the surface and through the soil, with the exception of a few small areas north of East Troy where the surface is free from gravel. The surface soil generally is a brown gravelly sandy loam or gravelly silt loam, extending to a depth of about 8 inches, underlain by a more or less gravelly subsoil, heavier in texture than the surface soil and ranging from a compact loam to a silty clay loam. Beds or loose porous sand and gravel are reached at depths of 18 to 30 inches.

The Fox loam, gravelly phase, occurs chiefly on slopes bordering lakes and streams, on slopes bordering potholes and various other depressions. The surface is irregular but seldom steep enough to interfere with the use of modern farm machinery. Because of the sloping nature of the surface, erosion has removed part of the surface soil in many places, leaving the heavier subsoil exposed. The natural drainage of the surface and subsoil is good and in places excessive.

The material forming this type has been derived from glacial debris which was reworked and deposited by streams as outwash plains and terraces. The gravelly material consists largely of limestone, and consequently the subsoil is never acid and the surface soil is seldom acid.

The native growth consists chiefly of oak, with some hickory and a little maple. Probably half of the phase is used for crop productions while the remainder is in forest or permanent pasture. The crops grown are the same as those produced on other soils of the region. The yields, however, are somewhat lower than those obtained on the loam and silt loam types. Alfalfa is probably the most promising crop because of the abundance of lime in the soil. In addition, alfalfa forms a protecting cover that helps to prevent erosion.

FOX FINE SANDY LOAM

Extent and distribution: The Fox fine sandy loam in its typical development is confined to the northern half of the county and is located mainly in LaGrange, Troy, and East Troy Towns, the largest area being in sections 11, 12, 13, and 14 in the town of LaGrange. Areas of medium texture which

approach a sandy loam occur in sections 1, 19, 20, 21, 28, 31 and 32 of Troy Town and sections 6 and 21 of East Troy Town. The type covers a total area of 3,648 acres or about 1% of the entire county.

Description: The surface soil of the Fox fine sandy loam is a dull-brown fine sandy loam to sandy loam, 8 inches deep. The subsoil is a yellowish or light-brown fine to medium sandy loam which grades at 20 to 24 inches into compact sandy loam or sandy clay. This material may continue to depths of more than 36 inches or it may pass into stratified sand and gravel within the 3-foot section. The type varies in texture and in places consists of a loamy fine sand or medium sand underlain by an upper subsoil of about the same texture, which grades into the heavier subsoil before the beds of sand and gravel are reached.

A variation included with this type consists of a surface soil of brown or grayish-brown sandy loam, with an average depth of 12 inches, and a subsoil of mottled yellowish and grayish sand, which extends to depths of 5 to 7 feet, where it is underlain by dense, heavy, calcareous clay having a pinkish or drab color mottled with yellow and gray. This heavy clay is similar in texture and structure to the subsoil of the Superior series of soil as found in other sections of the state. The depth to the heavy clay is variable but is seldom less than 4 feet. This variation occurs chiefly as slight swells and low knolls associated with soils of the Clyde series in the towns of Whitewater and LaGrange. The surrounding land is for the most part poorly drained and low. This soil occurs as slightly better drained areas, and although lying somewhat higher than the adjoining land, its drainage is somewhat deficient.

Topography and drainage: The surface of the typical Fox fine sandy loam is generally level, but locally it is slightly undulating. Where the type is lightest in texture it has in places been influenced slightly by wind action. Potholes are rather numerous and tend to make the surface irregular where there are several close together. Because of the texture of the soil and its underlying coarse material, the natural drainage is good.

Origin: The material giving rise to this type is of alluvial origin. It was deposited in its present position largely by streams coming from beneath the great ice sheet and occurs as

outwash plains or stream terraces. Most of the material has come from the grinding up of the underlying limestone by glacial ice, but has to some extent been modified by the action of water.

Native vegetation: The type was originally forested land and the tree growth was chiefly maple, hickory and oak. Practically all of the timber has been removed and the soil placed under cultivation.

Present agricultural development: Practically all of it is improved and devoted to the production of all farm crops suited to the region. The soil is especially well adapted to truck crops. It is easy to cultivate, warms up early in the spring, and responds readily to fertilization.

Most of the sandy subsoil variation near Whitewater is under cultivation and devoted to general farming and truck crops. It is best suited to the growing of truck crops and is so situated that it could well be used for gardening.

CARRINTON LOAM

Extent and distribution: The Carrington loam is of limited extent in Walworth County. It is found chiefly in the northwestern part of the county associated with Carrington silt loam. The typical soil covers an area of only 950 acres while the gravelly phase covers an area of 2,048 acres.

Description: The surface soil of the Carrington loam has an average depth of 10 inches and consists of dark-brown loam which contains considerable organic matter. The upper subsoil is a chocolate-brown loam which becomes yellowish brown at about 16 to 18 inches and grades into a sandy clay loam at about 20 inches. This gritty subsoil extends to a depth of more than 3 feet. Small quantities of gravelstones and occasional bowlders are found in places on the surface. The subsoil may also contain considerable gravel and stones.

This type is somewhat variable and ranges in texture from fine sandy loam to silt loam. Where the silty variation occurs the soil is deeper than typical. These variations give the type a somewhat spotted appearance, which differentiates it from the typical silt loam.

Topography and drainage: The surface of the typical soil ranges from nearly level to gently rolling. Because of the sur-

face features and the open character of the deep subsoil the natural drainage is good.

Origin: The Carrington silt loam has been derived from limestone material which was deposited by the late Wisconsin ice sheet. The glacial material is made up almost entirely of limestone, but the surface has been leached to such an extent that it is now in an acid condition. This acidity, however, does not extend to as great a depth in the loam soil as in the silt loam.

Native vegetation: This is a prairie soil and the main growth was prairie grasses. There was a fringe of timber along streams and bordering other types and in places such as gravelly knolls there was also a scattering of timber, but the growth was not heavy. Practically all of the timber has been removed.

Present agricultural development: Practically all of the type is under cultivation and in improved farms. About the same crops are grown as on the silt loam, but it is not quite as desirable a soil as the silt loam. Methods of improvement recommended for the silt loam will apply also to the loam. The most important lines of improvement are the correction of acidity and supplying the element phosphorus.

Carrington loam, gravelly phase: The surface soil of the Carrington loam, gravelly phase, consists of about 8 inches of dark-brown or nearly black loam which in places is somewhat sandy and gravelly. This is underlain by a chocolate-brown gravelly loam which becomes yellowish with increased depth. The subsoil is variable. In places the material below 18 inches is a gravelly clay loam which may extend to a depth of 3 feet or more. In other places it is more sandy. Locally the lower subsoil grades into unassorted clay, gravel, and sand, and in a few places into beds of sand and gravel within the 3-foot section.

The Carrington loam, gravelly phase, is associated with the Carrington silt loam and occurs scattered through practically all of the prairie regions, mainly in tracts of a few acres to 40 acres, although there are some larger tracts. It is a soil of minor importance from an agricultural standpoint.

The phase usually occupies gravelly ridges or knolls, and many of these are conspicious as they form a contrast to the

gently undulating silt loam. The natural drainage is sufficient and in places excessive.

The material forming the Carrington loam, gravelly phase, is of glacial origin and occurs chiefly as kames and eskers. The gravelly material is almost entirely limestone, and the subsoil is well supplied with carbonates. The surface soil, however, is usually found to be slightly acid. The degree of acidity is less than on any of the other Carrington soils. For this reason alfalfa will grow on the gravelly phase of the Carrington loam, whereas, on the Carrington silt loam it is sometimes difficult to secure a good stand of alfalfa without lime.

The greater part of the phase is under cultivation and is devoted to the general farm crops of the region. The yields are lower than on the Carrington loam or silt loam, and the phase as a whole is not as highly prized.

WAUKESHA LOAM

This soil is of comparatively small extent and therefore of minor importance. The largest area is in sections 21 and 22 in East Troy Town. Small patches occur in Troy and La-Grange Towns. None of the areas are of more than one square mile in extent, and most of them are much smaller. The typical phase covers 1,792 acres.

The surface soil of the Waukesha loam consists of a dark-brown to black loam 8 inches deep. This grades into a chocolate-brown subsoil, which becomes heavier and more compact with depth, takes on a yellowish-brown color below 14 inches. At a depth of 2 feet there is usually considerable gritty material, and beds of sand and gravel are reached at depths ranging from 20 to 30 inches. The surface of the Waukesha loam is level. The underlying sand and gravel insure good natural drainage.

The soil has been derived largely from glaciated limestone material deposited in the form of outwash plains and terraces. Although the lower subsoil contains much limestone material, the surface soil is acid and in need of lime.

All of this type occurs within the prairie regions. Most of it is included in improved farms and is devoted to the production of the ordinary farm crops of the area. Being somewhat lighter in texture it is better suited to special crops than the

heavy silt loam of this series, but the trucking industry has not been developed.

The methods of cultivation, fertilization, and crop rotation followed are practically the same as on the silt loam.

Waukesha Loam, gravelly phase: The Waukesha loam, gravelly phase, has the same relation to the Waukesha soils as the Fox loam, gravelly phase, has to the light-colored terrace and outwash soils. The surface soil for the most part consists of a dark-brown to nearly black sandy or silty loam, extending to a depth of about 8 inches. This is underlain by a gravelly subsoil that is somewhat heavier in texture than the surface soil and in places becomes a silty clay loam. Beds of loose sand and gravel are reached at depths ranging from 18 to 30 inches.

The gravelly phase occurs chiefly in Richmond, Darien, and Sugar Creek Towns. It covers an area of 892 acres. In a number of places it occurs within areas of Waukesha silt loam, deep phase, as terrace escarpments or bordering pothole depressions. It also occurs along the slopes leading to streams. This soil has been formed from glacial outwash material derived from the limestone till which covers the region.

The surface is somewhat irregular or sloping but seldom steep enough to interfere with the use of modern farm machinery. Because of the loose character of the soil and the sloping surface, the natural drainage is good to excessive.

The greater part of the Waukesha loam, gravelly phase, is included in farms and is devoted to the general farm crops of the region. It is probably better suited to alfalfa than the Waukesha silt loam because the gravelly subsoil contains much lime within reach of the roots of the plants. Where the surface soil has a dark color it is for the most part slightly acid. Where the surface soil has been eroded so as to expose the heavy subsoil, there is considerable lime near the surface.

In the use of this soil, efforts should be made to prevent erosion, and this may be done by keeping the surface covered with a growing crop as much as possible.

There is a fine sandy loam variation which is confined to small scattering areas in the towns of Troy, East Troy and La-Grange. It covers a total of about 448 acres. The surface is level and the natural drainage good. The surface soil is a dark colored fine sandy loam. The subsoil is a chocolate brown fine sandy loam which becomes more yellowish with depth and

usually grades into a sandy or gritty clay loam at 14 to 16 inches. Beds of sand and gravel are reached at 2 to 3 feet. This variation was so limited in extent that it was not considered advisable to map it as a separate type and therefore it was included with the Waukesha loam, since its agricultural value is about the same.

CHEMICAL COMPOSITION AND IMPROVEMENT OF LOAMS AND FINE SANDY LOAM

In this group of soils there are eight separate types most of which are of minor importance individually but collectively the group is important since it covers a total area of 49,390 acres or about 14 per cent of Walworth County. These soils are somewhat lighter in texture than the silt loams but where general farming is carried on practically the same methods of improvement can be followed as outlined for the silt loam soils on pages 35–39.

While there is some variation in the texture, structure and color of the types of soil in this group there is a sufficient similarity so that general methods of improvements discussed here will apply to the entire group.

Tests and observations which have been made on these soils indicate that most of the types are in need of lime. The dark colored prairie soils show a greater need than the light colored soils. There are a few exceptions to this need and these are found where the underlying limestone or gravelly till comes to the surface. Frequently, however, the soil will be in an acid condition even when the lime stone or gravelly till is within one foot of the surface.

The supply of organic matter in the dark colored types such as the Waukesha and Carrington loams is somewhat greater than the light colored types but in older cultivated soils this organic matter is in an inactive form so that the introduction of decaying vegetable matter will greatly aid in the improvement of these types regardless of color.

The supply of phosphorus in these loams and fine sandy loams is lower than in the heavier types and these soils show a marked deficiency in this element. The actual number of pounds of phosphorus which these soils contain, however, is not a true index of the actual need of this element. Some of the soils which show a small total amount do not respond as well

to an application of the phosphorus fertilizer as do the types which have a large amount present so that the behavior of the crop is a more important indication of the need of phosphorus than the chemical analysis.

Regarding the supply of potassium in the soil the total amount is approximately 25,000 pounds per acre or fully 20 times as much as the supply of phosphorus. Where general farming is conducted and where there is maintained a good supply of vegetable matter in the soil this will doubtless be sufficient. Where special crops are raised which require a large amount of potassium this element may be supplied to advantage in the form of a commercial fertilizer.

The principal characteristics of these types is that they hold somewhat less water than heavier soils do and they warm up more quickly in the spring. This together with the readiness with which they can be worked adapts them to truck and special crops, better than the growing of staple crops. It is necessary to give them somewhat more attention to maintain fertility partly because of the fact that they are lower in fertility than the heavier soils but more because of the fact that these special crops require a higher degree of fertility to produce satisfactory yields. When these soils are used for the production of special crops their fertility can be maintained either through the use of a rotation in which a legume is grown as the means of securing the necessary nitrogen and organic matter while the other elements, chiefly phosphorus and potassium, are supplied in commercial fertilizers. When this latter system is followed one-third or one-fourth of the land should be sown to a legume such as clover or soy beans which have large powers of gathering nitrogen from the air, and a part of the phosphorus and potassium should be used for the growth of different green manuring crops. The fertility used in this way will become available for the succeeding crops through the decomposition of the legume when plowed under and the remainder of the fertilizer to be used should be applied on this ground at the time of fitting it for the succeeding crops.

CHAPTER IV.

GROUP OF MISCELLANEOUS SOILS

MIAMI STONY LOAM

Extent and distribution: The stony loam occurs chiefly in rather large bodies in the morainic region in the northwestern part of the county, particularly in LaGrange and Whitewater Towns. A few smaller tracts are in other morainic parts of the county. The type covers a total area of 1,664 acres or 5% of the whole county.

Description: The Miami stony loam does not have the uniform characteristics of a district soil type. It includes areas of stony soils with extremely rough and irregular morainic surface features similar to those of the Rodman gravelly loam. This stony loam, however, differs from the Rodman gravelly loam in having a heavier covering of soil material over the underlying gravel. The surface soil ranges in texture, from place to place, from a heavy sandy loam to a silt loam. It is not very gravelly but is generally extremely stony, except in very small local areas. The subsoil is chiefly reddish brown in color, ranges in texture from loam to gritty compact clay loam, and extends to depths of 20 to 30 inches or more before beds of loose gravel are encountered.

Topography and drainage: Its surface is extremely rough and broken so that cultivated corn crops could not well be grown. The natural drainage is good, but seldom excessive, because the soil above the gravel is sufficiently deep to retain moisture.

Origin: This soil is of glacial origin and has been formed largely from the grinding action of glacial ice on the underlying limestone rock. Some of the type occurs in the form of kames and eskers but over the beds of gravel there is usually a covering of soil from 1-3 feet deep. The type is well supplied with lime but the subsoil contains considerable more than the surface soil.

Native vegetation: The forest growth consists mainly of red oak, white oak, and hickory with some poplar and birch. The best timber has been removed but there is still some left that would make posts, ties, and stove wood.

Present agricultural development: The chief use of this type is for pasture and it supplies good grazing for the entire season where cleared of timber and brush. This is in direct contrast with the Rodman gravelly loam, where grazing is limited to spring and early summer.

In the improvement of this soil there is not much that can be said except that it is advisable to keep the land in pasture as much as possible, but if the steep slopes are cultivated the danger of erosion would be greatly increased.

Where the land is not too steep or stony to be cultivated it might be advisable to plow and sow to alfalfa. Being well drained and well supplied with lime this type should produce excellent alfalfa. The amount of feed secured from the alfalfa, either as pasture or hay, would be much greater than from the native pasture. Once started, alfalfa would doubtless stand on this land for a number of years.

RODMAN GRAVELLY LOAM

The Rodman gravelly loam includes areas that are rather variable in texture and have a broken and rough topography. The surface soil generally consists of a brown or dark-brown loam, silt loam, or fine sandy loam, containing a considerable amount of gravel and extending to depth of 4-6 inches. This is frequently underlain by from 4 to 8 inches of extremely gritty clay loam which is underlain at from 8-12 inches by beds of stratified gravel. In places the layer of sand and gravel is less than this, and in others somewhat deeper.

The type occurs chiefly in LaGrange, Whitewater, Lyons, Geneva, and Troy Towns, and in a number of small scattering areas in other sections. The areas are all irregular and are associated chiefly with soils of the Miami series. In some places stones appear upon the surface, but these are usually not numerous.

The surface of the Rodman gravelly loam is extremely rough and broken, being made up largely of kames, eskers, and potholes. In many places the land is too steep for cultivated crops. Because of the uneven surface and the extremely

gravelly nature of the subsoil, the natural drainage is excessive and the type suffers from drought every year.

The material forming this soil has been derived largely from the underlying limestone through the grinding action of glacial ice. Over 90 per cent of the gravelly material consists of limestone. Much of it has been deposited by water underneath the the ice. This soil is not acid but contains large quantities of lime carbonate.

The native vegetation consisted chiefly of scrubby oak and hickory, and a considerable part of the type is still covered by a scattering growth of scrubby oak. The type is used chiefly for grazing and supplies good pasture during the spring and early summer. As soon as hot weather sets in, however, the grass dries up and is of little value for the remainder of the season. This soil should be kept for grazing, and the timber now standing should be retained in order to prevent erosion.

COLOMA FINE SAND

The Coloma fine sand consists of a grayish-brown loamy fine sand or loose fine sand, underlain at 6 to 8 inches by yellowish fine sand. Locally at depths of 30 to 40 inches it contains enough clay to make the sand slightly sticky, and in places the lower subsoil also contains small quantities of fine gravel.

This type covers a total of 1792 acres or about .5% of the county.

The Coloma fine sand occurs chiefly in LaGrange Town. The topography varies from gently rolling to rolling, and owing to the loose subsoil and the rolling surface, the natural drainage is excessive.

This type has been formed from glacial material probably derived in part from local limestone and in part from sandstone material carried by the ice sheet. This soil has been leached considerably since its first deposition, and practically all of the carbonates that may have been present originally have been leached from the surface soil, and an acid condition has developed.

The native forest growth consists of a rather scattering growth of oak, hickory, some poplar, and hazel brush. A large part of the type is cleared and in farms, and is being used for the production of the ordinary farm crops. Its productivity,

however, is rather low, and the general appearance of farmsteads is inferior to those of heavier soils. The type is better suited to the production of special truck crops than to general farming, and where it is favorably located for shipping it should be devoted to the trucking industry. The type responds readily to fertilizers and is in need of mineral plant-food elements and also nitrogen and organic matter. With the use of mineral fertilizers, good stands of clover can be secured, and by turning these under the organic content can be increased. Where the supply of manure is small, mineral fertilizers should be used. They may also be used to good advantage to supplement the manure and thus make it cover a larger acreage.

PLAINFIELD FINE SAND

The surface soil of the Plainfield fine sand is a light-brown fine sand 6 inches deep. The subsoil is a yellowish fine sand, which becomes somewhat lighter in color and extends to a depth of over 3 feet. Locally the lower subsoil is coarser in texture and may grade into beds of stratified sand and gravel.

This type occupies a total area of 2 square miles in the northern tier of towns, and occurs chiefly in LaGrange Town. The surface of this soil is level to gently undulating, and the natural drainage is good to excessive.

Small areas occur in Whitewater and La Grange Towns that are not typical. They are low lying and have a heavy clay stratum a few inches thick at shallow depth which interferes with the underground drainage. The surface soil is a brown or grayish fine sand underlain by a yellow or grayish and sometimes grayish and brown mottled fine sand which extends to a depth of 4 to 8 feet.

A dark phase is of very small extent and is confined chiefly to the town of East Troy. It covers an area of only 128 acres and because of its small extent it is not mapped separately but is included with Plainfield fine sand. The soil consists of a dark-brown to a nearly black fine sand or loamy fine sand, 8 to 12 inches deep, underlain by light-brown or yellowish-brown fine sand which usually grades into stratified sand and gravel at depths of less than 3 feet.

The surface ranges from level to gently undulating, and the natural drainage is somewhat excessive. The soil is of alluvial origin and occurs on terraces or out-wash plains. It is

practically all under cultivation, being devoted to corn or to the general farm crops of the region. The yields are slightly better than those obtained on the typical Plainfield fine sand.

The greater part of this type is cleared of the native cover, consisting chiefly of scrubby oak, and is devoted to the ordinary farm crops of the region. Yields, however, are considerably lower than on the heavier type. Corn, rye, small grains, and hay are the chief crops, but the type is better suited to special crops, such as potatoes or garden truck, than to general farm crops. The soil works up easily, warms up early in the spring, and responds readily to fertilization. More organic matter should be added, and complete fertilizers will give good results on this land.

To improve this type legumes should be grown, and to succeed with these it may be necessary to use commercial fertilizers. For this purpose a mixed fertilizer will be best, and a 2-10-4 will be well suited to this sandy soil. About 200 or 300 pounds per acre should be used. When clover is well established, a second crop may be plowed under to supply the needed organic matter. Where acid, the soil should be limed before best results can be expected from the mixed fertilizers. The use of lime will help to insure the success of clover. By following a short rotation in which a legume is grown and a part of it plowed under, and by supplying the mineral plant food elements through commercial fertilizers, good crops may be secured. A rotation consisting of clover, corn or potatoes followed by a small grain is well suited to this soil.

CHAPTER V.

GROUP OF POORLY DRAINED SOILS

CLYDE SILT LOAM

Extent and distribution: This soil occupies a total area of 41,280 acres or 11.5% of the entire county. From the standpoint of area it is one of the important types of the county. It is found in practically every township but is most extensive in the towns of Linn, Bloomfield, Geneva, Walworth, and Lima. Very few areas are over one square mile in extent, most of them ranging from a few acres to a quarter section.

Description: The surface soil of the Clyde silt loam consists of 10 to 16 inches of black heavy silt loam. The subsoil grades through a few inches of dark-drab or bluish silty clay loam into plastic silty clay, which passes at 20 to 24 inches into stiff, impervious, mottled clay or yellow silty clay. Lenses of mottled clay and yellow fine sand a few inches thick are found here and there in the deep subsoil. There are a few variations in the surface material; locally the soil is slightly heavier than silt loam, and in some places loam areas have been included.

As developed in the old glacial area, chiefly in Sharon Town, the surface soil consists of 12 to 16 inches of dark-gray to black silt loam containing much organic matter. The upper subsoil consists of a grayish, yellowish, or sometimes bluish silt loam, which rapidly grades into a silty clay loam, and generally becomes a strongly mottled impervious silty clay below 20 inches. The heavy material extends to a depth of 4 feet or more and rests upon unassorted glacial material. In some places the soil is heavier than a silt loam and could probably be classed as a clay loam or silty loam.

Topography and drainage: The surface is level and gently sloping or saucer-shape. The type occurs chiefly in long narrow strips occupying depressions in the upland; in places it occurs along drainage ways. It is all low-lying, and has poor natural drainage. Owing to its low position it frequently receives seepage from the adjoining high land. While the drain-

age is naturally deficient, the part which is the most elevated can sometimes be cultivated safely, although tile drains would be beneficial to all the land.

Origin: The material forming this soil consists for the most part of till derived by glacial action from the underlying limestone. As the soil occupies low places, there has been an accumulation of vegetable matter, the decay of which accounts for the dark color and the high organic content. Since this soil has been derived from limestone material and has received the wash from the higher land, it is well supplied with carbonates and but little of it is acid.

Some of the type occurs as low terraces or outwash plains and has the same origin as the Waukesha but is lower and more poorly drained. The phase which is found on terraces has been leached more than the ice-laid phase and is frequently found to be in need of lime. This variation was too limited to be shown separately on the soil map.

Native vegetation: The original forest on this soil consisted of ash, elm, alder, and willow. Most of the merchantable timber has been removed, but there are still a few trees available for saw timber.

Present agricultural development: Probably half of the Clyde silt loam is under cultivation. The cultivated land is partly drained and lies between the upland and the lowest parts of depressions. Part of the type is too poorly drained to be cultivated. Where the drainage is sufficient corn, root crops, small grains, and hay are being grown, and where the drainage is not so good the land is used for pasture.

Drainage is of course the first and most important step in the improvement of this type. When completely drained it is one of the best types for corn in southern Wisconsin. It is also well adapted to sugar beets, cabbage, and hay. Small grains are inclined to lodge and the quality of the grain is not quite equal to that grown on the upland soils. Wherever there is a small accumulation of peat or muck over the surface, the use of mineral fertilizers containing phosphorus and potash might be advisable during the early stages of cultivation. As the peat becomes mixed with the mineral soil by cultivation, the need for mineral fertilizers will be reduced.

For additional information on the management and improvement of this soil see page 60.

CLYDE CLAY LOAM

Extent and distribution: This soil covers a total area of 6,528 acres or nearly two per cent of the whole county. It is most extensive in the town of Whitewater but smaller tracts occur in nearly every town in the county.

It is associated with soils of Miami and Carrington series and forms part of the lowlands of the county.

Description: The Clyde clay loam consists of a black silty clay loam passing at a depth of 10 to 14 inches into mottled drab and yellow silty clay, which grades at from 18 to 30 inches into a dense, heavy, impervious clay, mottled with gray and yellow, and in places with an indication of a peculiar pinkish color typical of the Superior soils mapped in other parts of the State. Both the soil and subsoil are calcareous. This type includes several variations. The texture varies from a silty clay loam to a clay loam and even to a heavy clay, but because of its limited extent these variations were all grouped under the head of clay loam. The subsoil also varies. In places the heavy material extends to a depth of over 3-4 feet while in other places of limited area there are thin layers or beds of fine sand in the deep subsoil between 3-4 feet below the surface.

Topography and drainage: The type has a flat surface and a rather low position, lower than the Waukesha soils with which it is sometimes associated. The natural drainage is slow, but is naturally good enough or can be improved so as to be sufficient for general farm crops. From the standpoint of drainage the type includes two classes of land, one which is sufficiently drained to allow cultivated crops to be grown, and the other which is in a rather marshy condition and too wet for cultivation at the present time. This marshy land can all be drained and will, when improved, be equally as good land as that which is now being farmed, the soil material being practically the same. Artificial drainage is needed over a large proportion of the Clyde clay loam.

Origin: The typical Clyde silt loam occupies poorly drained depressions in the glacial till regions and the soil material has come largely from the underlying limestone formation through the grinding action of glacial ice. The low poorly drained condition favored a rank growth, the decay of which has result-

ed in the high content of organic matter and the dark color. A phase of the Clyde clay loam occurs on low terraces or outwash plains and has the same origin as the Waukesha soils. The typical soil is seldom acid but the terrace or outwash phase has been leached and acted upon to a greater extent by water and much of the limestone material has been removed. An acid condition has developed over most of this phase of the type.

Native vegetation: Some of the areas in Walworth Town are probably part of the prairie in that section. Most of the other tracts supported some forest, mostly elm, soft maple, and ash.

Present agricultural development: Probably half of the clay loam is under cultivation, and where fairly well drained it produces good crops. Drainage, however, is the important feature in improving this soil, and until artificial drainage has been supplied, crops can not be grown successfully year after year. When thoroughly drained, this is a strong, productive soil, well adapted to corn, hay, and root crops.

CHEMICAL COMPOSITION AND IMPROVEMENT OF CLYDE CLAY LOAM AND CLYDE SILT LOAM

These two types occupy a total of about 13.7 percent of the county, and form a substantial part of the best agricultural land in the region. They are characterized by having relatively large amounts of organic matter, accumulated as a result of poor drainage. The supply of organic matter is quite variable since the soil grades into Muck and Peat on the one hand and into upland mineral soils on the other. Chemical analyses of such soils show that the nitrogen content varies from 4,000 to 10,000 pounds per acre 8 inches. The supply of phosphorus runs from 1,000 to 2,460 pounds per acre while potassium usually runs from 25,000 to 40,000 pounds per acre or more. Where the soil has a thin covering of Peat the phosphorus and potassium are present in the surface soil in considerable smaller amounts.

The portion of these soils found on Terraces usually show some need for lime and ground limestone on such places can be used to advantage. Over most of the region, however, these soils do not need lime. They are so situated that they receive the wash from higher lands, which contain lime material, and this lime bearing water has prevented the development of an acid condition in these lands. Where acidity is found it is

usually so slight that but little if any lime is needed, except as indicated above.

The most important step and the first step in the improvement of these soils is to supply adequate drainage. Tile drains and some open ditches have been installed and a portion of the land is now devoted to cultivated crops. Considerable areas, however, are still undrained, and are used chiefly for pasture and hay. The drainage of these lands frequently requires the development of drainage districts, but there are numerous tracts which are so situated that they can be reclaimed by individual efforts.

A condition which sometimes develops on this soil is shown when corn turns yellow on areas of small extent. In such cases the use of some form of potash or strawy horse manure is helpful. There is relatively a much larger supply of nitrogen than phosphorus and potassium. For this reason it is a good practice to use the manure on the upland soils which are deficient in nitrogen and apply mineral fertilizers to the low land when these are needed. In many cases which show a marked need of potassium during the first few years of cropping, usually where the soil is high in organic matter to a depth of a foot, this lack of potassium frequently disappears after a few years of cropping as a result of the settling of the surface so that deep plowing mixed up some of the soil high in potash.

In spite of their large content of both phosphorus and potassium, it is not infrequently true that these soils show low availability of these elements, especially of potassium. This is probably due to the inert condition of much of the organic matter which protects the earthly part of the soil. Where thoroughly good artificial drainage has been developed and nevertheless poor crops secured, this result will usually be found to be due to lack of available potassium and in some cases also of phosphorus. A direct experiment should be made in these cases with potassium and phosphate fertilizers, as suggested in the bulletins of the Experiment Station.

These soils are capable with thorough drainage and proper fertilization and cultivation of being made among the most productive lands in the state. Within hauling distance of Racine and Kenosha these same soils are being utilized to some extent for trucking, and this industry could be developed in

Walworth County where locations are favorable and markets within reach. All of these lands not now being farmed should be drained and put to work, for it is an economic loss to have them idle.

CLYDE LOAM

Extent and distribution: The Clyde loam covers a total area of 2,172 acres or less than 1% of the entire county. It is found most extensively in Whitewater and LaGrange townships though small patches are found in other parts of the area. The Clyde loam is closely associated with Peat and with other types of the Clyde series.

Description: The Clyde loam consists of 12 to 18 inches of a black loam, passing through brown loam into mottled yellow and brown sandy loam at 20 to 24 inches, below which it is a mottled yellow and gray loamy sand. The subsoil is somewhat gravelly in places, and is underlain at depths of 4 to 6 feet by dense impervious clay similar to the lower subsoil of the Poygan series. The surface soil is somewhat variable in the depth of the dark-colored material as well as in texture. The depth to the heavy material in the deep subsoil is also variable. In some instances this heavy material appears to be lacking. In some places the surface soil was found to be a fine sandy loam but such variations were too limited to map separately.

Topography and drainage: This soil occupies low, level, or somewhat depressed areas and the natural drainage is deficient. Part of the land is in a marshy condition during a portion of each year and all of it should be tile drained before maximum crops can be expected from year to year. There are some areas where the surface is sufficiently well drained so that fair crops are being grown without artificial drainage, but there is always some danger during periods of heavy rainfall of there being an excess of moisture.

The better drained areas are the same from the standpoint of texture, color, etc. as the more poorly drained portions of the type, but occupy a position a foot or so higher and frequently have more fall than the remainder of the type.

Origin: The Clyde loam was formed in two ways. Part of the soil represents depressed areas in the glacial till which was derived from the underlying limestone by the action of glacial ice. Part of the type was derived also from outwash or valley

fill hill material which came originally from the same parent rock but which was acted upon to a greater extent by water. The water deposited phase, having been leached most, may be in need of lime in places, while the till phase seldom needs lime.

Native vegetation: The native growth on this soil consisted of ash, elm, soft maple, with some alder, willow, etc.

Some of it was rather open and only sparsely covered with brush and trees. Most of the timber of value has been cut but there is still some suitable for fire wood and possibly a few trees suitable for saw timber, together with some brush.

Present agricultural development: The Clyde loam where cultivated is used for corn, hay, pasture, and to some extent for small grain, but the soil is cold and wet in the spring and crop yields are often unsatisfactory. In many instances the crops are spotted and uneven owing to poor drainage conditions. When well drained this land is well suited to general farm crops and is classed as good land, especially adapted to corn. It is also suitable to such crops as cabbage and onions where marketing conditions are favorable.

Chemical composition and improvement: This soil is somewhat variable in its physical properties. Its supply of nitrogen, phosphorus, and potash is somewhat smaller than in the silt loam, but it contains more organic matter than do the light colored upland soils and contains a fair amount of phosphorus and potash. In its improvement drainage is the first and most important step. When this has been supplied, this soil is well adapted to the growing of general farm crops, but it is also well suited to special truck crops. Where favorably located, it should be devoted to these special truck crops rather than to the growing of general farm crops. When well drained, it warms up readily, is easy to cultivate and therefore very desirable for the growing of crops which require intensive cultivation.

GENESEE SILT LOAM

The Genesee silt loam as mapped in Walworth county includes a variety of soil materials all of which occur as first bottom land chiefly along Honey Creek, Turtle Creek, Sugar Creek and White River and in small areas along other streams chiefly in the north half of the county. This type as a whole

may be divided into two divisions or phases. The more extensive or dark phase covers 6,208 acres and a lighter phase covers 768 acres which in all makes a total of 1.9% of the entire county that is covered by the Genesee silt loam. The light phase which is the portion of the type more nearly typical of this soil as mapped elsewhere in the State consists of a medium to dark brown smooth friable silt loam underlain by mottled, drab and yellow silt loam which in places approaches a clay loam in texture. This contains numerous lenses of fine sandy material. These sandy layers vary from 1 to several inches in thickness. In places the subsoil to a depth of 3 feet is practically free from sand while in other places the greater portion of the soil section may be sandy. This lighter portion of the type occurs chiefly in Richland township with other small pieces in Troy and East Troy townships.

The darker portion of the type which might be considered as a dark phase or variation consists of a brown to nearly a black, smooth silt loam which ranges in depth from 8 to 18 in. but in some places extends to a depth of 24 in. The supply of organic matter is variable and in places is sufficiently high to make the material approach a muck. The subsoil is a drab or mottled gray and yellow silty clay loam. Lenses of fine sandy loam and gravelly material, a few inches in thickness may occur throughout the subsoil. where the organic matter is highest, the soil is frequently dark enough so that if it had been of sufficient extent it could have been mapped as Wabash silt loam.

The surface of the Genesee silt loam is all low, level or depressed and the natural drainage is poor. Practically all of the type is subject to annual over flow.

The material forming this soil has been deposited by flowing water and is derived from the glaciated limestone material that forms the upland soils of the region. The leaching of the water through the upland soils and its draining on to the lower lands keeps this lowland from becoming acid. The subsoil frequently contains a considerable amount of lime carbonate.

The native vegetation consists chiefly of elm, ash, soft maple, willow and alder. Most of the merchantable timber has been removed but on the larger areas there are still some trees that are suitable for saw timber.

Nearly all of the type is unimproved as most of it is too wet

in its natural condition for cultivated crops. In a few places where it adjoins the higher land it is cultivated and in dry seasons produces good crops. However, the danger from excess moisture is so great as to discourage the cultivation of this type of land. Some of this soil is in grasses and supplies good grazing a part of the year. Drainage, of course, is the most important factor in the improvement of this soil. This would call for the deepening of the drainage ways in most cases. When some of the larger marshes are drained portions of this type will also be greatly benefited. When thoroughly drained and placed under cultivation it will become a productive soil especially adapted to corn and seldom injured by frost.

The large water-holding capacity of such soils together with their large quantity of nitrogen makes them suitable for crops, making strong growth of stock or leaf. Among the staple crops, hay and corn are best suited to such land. Special crops such as cabbage, hemp and sugar beets also do well, but these will require larger amounts of potassium and phosphorus fertilizers. The degree of drainage must also be considered in selecting the crop to be grown. Timothy and alsike clover for hay may be grown on land having insufficient drainage to be adapted to corn or other crops requiring tillage.

Drainage: In Walworth County there are over 80,000 acres of land which may be classed as poorly drained, and which must be provided with open ditches or tile drains before cultivated crops can be safely grown from year to year. This includees 41,280 acres of Clyde silt loam, 29,248 acres of peat, and 6,528 acres of Clyde clay loam and 2,176 acres of Clyde loam, and the Genesee silt loam. In addition to these soils, there are places on the level prairie and also in the light-colored terrace soils where the lands are somewhat deficient in drainage, and where tile drains can be used with profit. It is safe to say that there are approximately 100,000 acres of land in Walworth County which could be profitably improved by drainage.

The soils mentioned above are, for the most part, unimproved, or are used only for grazing or for the production of wild or tame hay. The Clyde silt loam and clay loam, when drained, make some of the best types for corn in southern Wisconsin, and to have it in its present undrained condition is an economic loss. The peat is less valuable, but its improvement by drain-

age will greatly add to the producing possibilities of the county. The Clyde loam is a good trucking soil when drained. Practically all of these lands can be successfully drained, and every farmer having poorly drained land should develop a plan by himself, or with his neighbors for the improvement of these idle acres.

Since over 20 per cent of the land in Walworth County is failing to do its duty because of poor drainage, and since well-drained land adjoining is worth from $100 to $200 per acre, it would seem that the improvement of such land would be a matter of vital concern to the county as a whole. If this land were all in corn and properly handled, it would yield at a conservative figure over three million bushels per year.

For a more detailed discussion of the problem of management of marsh soils and drainage, see Bulletins Nos. 284 and 309, Wisconsin Experiment Station.

PEAT

Extent and distribution: Peat occurs in all towns and is more widely distributed than any other type in the county. The largest tracts are in the towns of Troy, Richmond, Sugar Creek, Whitewater, and Bloomfield. These larger tracts cover from 2 to 4 or more square miles. There are many tracts that vary from a few acres to one-half square mile in extent. There are in the county 28,032 acres of Typical Peat and 1,216 acres of Peat shallow phase.

Description: Most of the type mapped as Peat consists of dark-brown or black fairly well decomposed organic matter passing at from 10 to 18 inches into lighter brown and less well decomposed material. In the larger areas the surface material in places is only slightly decomposed and lighter brown in color. In such places the original form of vegetation may be plainly seen and the bulk of the material is fibrous. In the small areas the sloping portions are sometimes of a springy nature and the black thoroughly decomposed Peat may extend to a depth of over 3 feet. In some places the peat is over 10 feet deep.

The subsoil under most of the Peat consists of heavy matererial ranging from gritty loam to silty clay loam. Where the neighboring upland is sandy, however, the material is frequently sandy below the Peat. In several places the Peat is

underlain by marl. The depth of the Peat is somewhat variable, but will average more than 3 feet. Where the depth to the mineral soil is less than 18 inches, a shallow phase of Peat has been mapped.

Topography and drainage: The Peat is all low lying. The surface is level or very gently sloping, and the natural drainage is extremely poor. Some of it is subject to overflow and over a great deal of it the water table remains close to the surface most of the time.

Origin: The material forming the Peat has been derived from the growth and accumulation of vegetable matter which is now in various stages of decomposition. In some cases this material is still raw so that the original fiber can still be seen. In other places it is thoroughly decomposed so that the original structure has entirely disappeared. In some instances, especially around the border of marshes, a varying amount of mineral matter has been mixed with Peat, so that the result is soil approaching Muck. Because of the limited extent of this variation, however, the Muck is not shown separately on the soil map.

Owing to the large content of lime material in the deep subsoil throughout the upland, and because the water leaching from the upland and accumulating in the marshes carries lime, the Peat soil is not acid. A number of acidity tests were made on the Peat but only in a very few instances was an acid reaction obtained. There appears to be no relation between the degree of decomposition and acidity.

Native vegetation: Some of the marshes are treeless in part and are covered with a growth of sphagnum moss and coarse marsh grasses. The original tree growth in places consisted of dense growth of tamarack, while in other places the growth was ash, alder, willow brush, and a scattering of tamarack. Some ash was also found where the peat is shallow. Some marshes are partly open and partly forested.

Present agricultural development: Most of the large marshes are now included within drainage districts and many outlet ditches have been or are being constructed. In most cases, however, only the outlet ditches have been constructed and lateral open ditches or tile drains have not yet been put in. When this land is thoroughly drained and properly fertilized, it will be adapted to a number of crops, including corn, sugar

beets, cabbage, onions, and hay. Some grains may also be grown, but there is considerable danger of lodging and the grain does not fill out as well as on the upland soils.

Drainage is the first step necessary in the improvement of this type, and until thorough drainage is supplied it is useless to attempt cultivation. At present the Peat marshes are used chiefly for the production of marsh hay and some pasture. Only in a very few cases are cultivated crops being grown. Little tiling has been done on the Peat lands, but the importance of this is being appreciated and more attention than ever before is being given to the reclamation of the marsh lands. Because of the high value of the upland soils, it is desirable that the Peat soil should be under cultivation as soon as possible so as to make every acre on each farm productive.

When the deep Peat is thoroughly drained, properly cultivated, and fertilized, it will have a crop producing power nearly if not quite equal to the upland, and will have a selling value of probably about two-thirds or three-fourths that of the adjoining upland. It will have a lower selling value because it is not adapted to as wide a range of crops as the upland soils and also because it requires special treatment with which many people are not familiar.

Peat, shallow phase: The shallow phase differs from the typical Peat chiefly in the depth to the heavier underlying mineral soil. The peaty material in the shallow phase has a depth of 18 inches or less. Where associated with sandy upland the underlying material is usually sandy, and elsewhere it is heavier. The soil section itself down to the mineral soil is practically the same as that of the deep Peat, consisting of decaying vegetable matter of a dark-brown or black color, with which there has been mixed a comparatively small proportion of mineral matter. The lower part of the peaty layer in places contains considerable mineral matter, especially where the subsoil is sandy, as in the areas mapped in the northern parts of LaGrange and Troy Towns.

The greater part of the shallow phase occurs in Troy and LaGrange Towns, but small areas also occur in most of the towns in the northern half of the county.

In regard to drainage, origin, and native vegetation this phase is practically the same as the typical peat. It has not been developed agriculturally to any extent, but a few small

Celery growing on Peat soils near Lake Geneva.

Large traction ditches of this kind are used in drainage work in Walworth county. The trench which this machine digs is very satisfactory for the laying of tile.

areas have been placed under cultivation. Before much of it can be utilized for cultivation, it must be thoroughly drained. Where the subsoil is heavy, this shallow Peat has a greater potential agricultural value than the deep Peat, because when the land is cleared and thoroughly drained the surface material will settle to such an extent that in many cases the heavy subsoil will be mixed with it in the cultural operations. When this land is thoroughly drained, properly cultivated, and fertilized, it will have a crop-producing power nearly equal to that of the upland soils.

AGRICULTURAL VALUE AND DEVELOPMENT OF PEAT

The amount of marsh land occurring in Walworth County so well located with reference to market and transportation facilities makes it important to consider its agricultural possibilities quite fully. At present only a very small proportion of the peat soil in this county is improved.

The question of the actual value of marsh land is one which depends on several factors. In the first place, the farmer whose land is largely upland and well drained can use a small amount of marsh land to very much better advantage than can the farmer whose land is essentially all marsh land. But probably the most important factor determining the value of marsh land will be the crops which can be grown on it. This depends on two factors, first the degree of drainage, and second the danger from frost. When only the main outlet and lateral ditches have been installed, in the great majority of cases hay crops are the only ones which can be safely grown, and the character of the hay will also depend a good deal on the character of the drainage. In the case of peat land underlain by sand the drainage by well-constructed and sufficiently deep ditches 40 to 80 rods apart will, in most cases, give adequate drainage for this purpose. When the peat soil is underlain by silt or clay, however, ditches not more than 20 rods apart will be necessary and these must lower the water in the ditch to a point 4 or 5 feet below the surface during part of the growing period. When tiled crops, such as corn, cabbage, or potatoes, or small grains are to be grown, the drainage systems in the form of either open lateral ditches or of tile not more than 10 and often not more than 5 rods apart on the average.

Another factor which must be considered in comparing marsh and upland soils is that of fertility as determined by chemical composition. Marsh lands are abundantly supplied with organic matter containing nitrogen, but are relatively low in potassium and sometimes phosphorus. The marsh lands of Walworth County are seldom in need of lime since the acidity which ordinarily develops in marsh land is kept neutralized by the lime carried down from surrounding uplands. A few of the marshes show some need of lime. Stable manure can be used for fertilizing marsh land, but it contains large amounts of nitrogen, which the marsh soil does not need and is relatively low in phosphorus and contains but a moderate amount of potassium. Moreover, weeds so commonly carried into the land with stable manure are especially hard to eradicate on this class of soil. Ordinarily, therefore, it is more satisfactory to use potash fertilizer on marsh soils than stable manure. At any rate this is true when the farm contains some upland soils as well as marsh land, since the stable manure can be used on the upland while the potash fertilizer is secured for use on marsh land.

Marsh lands are more subject to early fall and late spring frosts than are uplands, partly because of the fact that the cold air developing in contact with the soil as the latter loses its heat by radiation during the night, flows down and collects over the lower land, and partly because the loose, spongy nature of the peat soil prevents the heat of the sun from penetrating so that all except the mere surface is cool, and this loses its heat quickly at night, thereby increasing the tendency to frost. This loose character of the soil can be somewhat improved by the use of a heavy roller which firms the soil and so gives it better heat conductivity. This tendency to frost reduces somewhat the availability of marsh land for tender crops, but in Walworth County, potatoes and corn on marsh lands

The following tables show the results of fertilizer tests on the Peat Marsh at the University of Wisconsin. The Peat in the University Marsh is practically the same as that found in Walworth county and the results will apply to the peat lands of this county.

CORN YIELDS FOR FIVE YEARS ON UNIVERSITY PEAT MARSH EXPERIMENTAL LOTS

Plot No.	Fertilizer Treatment	A 1919	C 1920	B 1921	A 1922	C 1923	5 Yr. Ave.	Ave of Duplicate
		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
1	12 Tons Manure	80.3	53.5	77.9	60.5	62.0	66 8	70.6
2	200 lbs. KCL	83.4	43.6	84.5	58.5	64.3	66.9	67.7
3	Check	34.6	18.6	32.7	29.7	25.7	28.3	22.8
4	200 lbs. KCL 400 lb.s 16% acid phosphate	71.4	55.6	81.7	56.8	64.6	66.0	68.1
5	62.5 KCL 62.5 16% acid phos in hill	69.7	57.9	86.0	52.2	55.4	64.2	62.0
6	200 lbs. MCL 1,000 lbs. Rock Phosphate every 6 years	72.4	48.0	80.6	33.7	58.3	58.6	58.9
7	125 lbs. 0-10-10 in hill	59.2	30.7	40 9	37.7	45.7	42.8	39.6
8	Check	38.2	9.1	25.2	15.1	20.0	21.5	
9	12 Tons Manure	86.7	65.8	107.3	49.7	62.6	74.4	
10	200 lbs. MCL	73.9	45.2	91.8	59.1	72.3	68.5	
11	200 lbs. KCL 400 lbs. 16% Acid phosphate	71.6	62.2	92.3	54.5	70.9	70.3	
12	62.5 lbs. KCL 62.5 lbs. 16% Acid phosphate in hill	59.7	52.7	91.8	51.4	42.9	59.7	
13	Check	30.7	6.5	22.6	14.8	18.6	18.6	
14	200 lbs. KCL. 1,000 lbs. Rock phosphate. Once every 6 yrs.	67.7	27.1	86 3	54.0	60.6	59.1	
15	125 lbs. 0-10-10 in hill	34.8	20.4	36.6	39.4	52.3	36.7	

Note—KCL is Muriate of Potash.
0-10-10 is a mixted fertilizer containing 10% Potash and 10% Phosphate.
Yields given are on the basis of bushels per acre.

HAY YIELDS FOR FOUR YEARS ON UNIVERSITY MARSH—EXPERIMENTAL PLOTS

Plot No.	All fertilizers have been applied 2 years previous to the corn crop.	B 1920	A 1921	C 1922	B 1923	4 yr. Ave.	Ave of Dup. Plots
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	12 tons manure	6000	4500	1120	2960	3645	3625
2	200 lbs. KCL	5280	4400	1680	3140	3625	3645
3	Check	4400	2940	1200	1600	2535	2205
4	200 lbs. KCL, 400 lbs. 16% Acid phosphate	5560	4460	2000	3200	3805	4010
5	62.5 KCL, 62.5 Acid phosphate in hill	5300	3040	2240	2280	3215	3212
6	200 lbs. KCL, 1,000 lbs. rock phosphate once every 6 years.	5640	4000	1920	2780	3585	3342
7	125 lbs. 0-10-10 in hill	3740	2600	1600	2100	2510	2450
8	Check	3080	2040	1760	1300	2045	
9	12 tons manure	5400	4300	2080	2640	3605	
10	200 lbs. KCL	5520	4500	1120	3520	3665	
11	200 lbs. KCL, 400 lbs. acid phosphate 16%	5820	4360	2400	4280	4215	
12	62.5 lbs. KCL, 62 5 16 %Acid phosphate in hill	5140	3540	1440	2720	3210	
13	Check	4280	2960	960	1940	2035	
14	200 lbs KCL, 1,000 lbs rock phosphate once every 6 years	5440	4260	960	1780	3100	
15	125 lbs 0-10-10 in hill	3440	2580	1280	2260	2390	

Note—KCL is Muriate of Potash
0-10-10 is a mixed fertilizer containing 10% Potash and 10% Phosphate
Yields are given on the basis of pounds per acre
The rotation followed on this land is Corn, Oats and Hay, with fertilizers applied to the corn crop

CHAPTER VI.

GENERAL AGRICULTURE AND CLIMATE OF WALWORTH COUNTY

TYPES OF FARMING AND CROPS GROWN

At the present time general farming is practiced in all parts of Walworth county. In conjunction with general farming the dairy industry has been developed to a marked degree until Walworth County is one of the foremost in the production of dairy products.

Dairying is the most important industry in the county. In 1919 there were 38,714 dairy cows, which is 69 cows for each square mile in the county. The human population numbers only 41 to each square mile. For the county as a whole there are 1.6 cows for each person. The cows of Walworth County on the average are milked for 341 days in the year. During this time the production is 18.3 pounds of milk per day per cow. This means an annual production of 5,523 pounds per cow. The total milk production in 1919 amounted to 2,138,174 hundred weight, which had a value to the producers of $6,606,-958. This was the year of highest prices, and these prices were considerable above the average. Cattle of Holstein breeding are the most common in Walworth County, and there are a number of pure bred herds which have a national reputation. A very high standard is being maintained in the dairying industry, the herds are kept free from tuberculosis by frequent tests, and many of the cows are sufficiently high in production to make them eligible to the advanced registry. While there are more Holsteins than cattle of other breeds, there are also herds of Guernseys and Jerseys in the county. There are also herds of Brown Swiss which are giving good account of themselves.

LIVE STOCK STATISTICS

	April 15, 1910 (U S Census	Jan 1, 1919 (Assessors)	Jan 1, 1920 (Assessors)
No of Milk Cows	39,147	37,960	39,932
No of Other Cattle	21,500	25,120	23,738
Swine	56,528	29,232	37,118
Horses and Mules	13,328	12,925	12,247
Sheep	16,635	22,395	19,133

While dairying is the leading industry in the county, there are other extensive live stock products. In 1909, according to the census, the value of animals sold and slaughtered approximated $1,500,000. This included about 55,000 hogs, 24,000 sheep, and 23,000 calves. The extent of the live stock industry will be appreciated when an examination is made of the following table which gives the live stock population of the county over several years. There are more than two and one-half times as many cattle as there are people and about one and one-half times as many pigs as there are people.

While the dairy industry represents the greatest industry and while the county is known as a dairy county, the production of beef cattle is not overlooked, and there are a number of farms on which pure bred beef cattle are being raised, both for breeding purposes and for the block. The Shorthorn is probably raised more extensively than other beef cattle, but there are Herefords, Angus, and Shorthorns and Red Polled are sometimes classed as dual purpose breeds.

On every dairy farm hogs are also raised, and their value adds materially to the income on nearly every farm in the county. In 1919 there were over 56,000 hogs in the county, which on January 1, had a value of $733,300. Among the leading breeds are Duroc Jersey, Berkshire, Poland China, and Chester White.

Walworth County is not usually considered as a sheep country, yet on January 1, 1919, there were 22,395 sheep in the county. At that time they had an average value of $12.00 per head.

Poultry is raised on practically every farm, and many of the farms have some income from this source, although very few specialize in poultry husbandry.

Horses have been depended upon in the past for all of the

field work. During the last few years many farmers have purchased tractors and are doing much of the plowing and other heavy work of the farm with these machines. In most cases the tractors are proving to be satisfactory, especially on the larger farms and they are actually replacing some of the horse labor. The majority of the farm work, however, is still being done with horses, and in 1919 there were 12,247 horses and mules in the county. There are but few farmers that make a specialty of breeding horses, but quite a number raise from one to three or four colts and keep themselves supplied with working stock and frequently have a team to sell.

There is a very wide range of topography in Walworth County, and this has had some influence upon the development of agriculture and the types of farming which are followed in various sections. The topography ranges from level to extremely rough and broken. On the level prairies, agriculture is very highly developed, and practically all of the land is highly improved. On the most broken areas, such as are included in the morainic belts, some of the land is too steep to be used for cultivated crops and has value only for grazing purposes and forestry. Between these two extremes all graduations are found. It may be said, however, that there is only a comparatively small total area which is too steep to be used for cultivation, although some of the fields which are now being tilled are subject to more or less erosion because of the steep slopes.

In the following table there is given a list of the various crops which are grown in the county and the acreage devoted to each, covering a period of several years. It will be noted that these figures are taken from the United States Census reports and partly from the records of assessors.

STATISTICS OF FARM CROPS

		1879 Census	1909 Census	1917 Assessors	1918 Assessors	1919 Assessors
Acreage of all Cultivated Crops			168,444	177,147	181,867	
Clover and Timothy	Acres	32,844	44,760	45,390	35,564	36,002
	Yield			1.5 T.	1.4 T.	1.7 T.
Corn	Acres	63,456	58,086	62,200	57,621	60,648
	Yield Grain	38.7 Bu			38 Bu.	48 Bu.
	Silage				8 T.	8.2 T.
Oats	Acres	52,167	34,293	38,620	41,438	41,780
	Yield	42.6		51	54	27
Barley	Acres	10,135	24,423	19,400	29,988	17,689
	Yield	31		36	39	27
Spring Wheat	Acres		574	2,600	8,044	14,948
	Yield	1,091		23	29	15
Winter Wheat	Acres		77	375	165	396
	Yield			24	35	24
Rye	Acres	1,466	938	1,500	1,395	2,318
	Yield	17		20	24	18
Potatoes	Acres	2,203	3,054	2,900	2,388	1,839
	Yield	98		99	84	61
Alfalfa	Acres		1,538	3,100	1,507	2,933
	Yield			2.6 T.	2.4 T.	2.8 T.
Buckwheat	Acres	383	332	150	232	153
	Yield	10		15	13	11
Peas (dry)	Acres			120	265	148
	Yield				19	15
Beans (dry)	Acres	84	10	16	56	10
	Yield	12			17	11
Marsh Hay	Acres	11,038	7,927	4,500	4,832	5,571
	Yield			1.3 T.	1.4 T.	1.4 T.
Tobacco	Acres	30	15	15	10	6
	Yield	1,341 lbs.			1,200 lbs.	1,200 lbs.
Sugar Beets	Acres		44		226	194
Peas for Canning	Acres		42		371	417
Flax	Acres	17			15	55
Sorghum	Acres	59				
	Yield	75 gal	per acre			

From this table it will be noted that the most important crops from the standpoint of acreage are corn, oats, hay, barley, and wheat. In addition to these there are a number of other crops which are quite important, but which have a smaller acreage.

Corn occupies a larger total acreage than any other crop. In 1919 there were 60,648 acres which produced an average yield of 47 bushels to the acre where the corn was harvested. Where the corn was cut for silage, it averaged 8.2 tons per acre. During this same year 51% of the corn was cut for silage. Corn is grown in all parts of the county and on all

soil types, but under present conditions the Carrington and Waukesha silt loams are the most favored for corn production. When thoroughly drained the Clyde silt loam is undoubtedly the best corn soil in the county. Its acreage, however, is limited, and at present only a small proportion of this type of land has been reclaimed by drainage.

Oats were grown on 41,780 acres in 1919 and produced an average yield of 27 bushels to the acre. The yield of this crop varies greatly from year to year. The average yield for 1918 was 54 bushels, and in 1917 it was 51 bushels. Oats are grown on practically all of the well drained soils and produce satisfactory yields except on the extremely sandy soils.

Timothy and clover are grown on about 36,000 acres and in 1919 yields about 1.7 tons per acre. During this year over 60% of the hay crop consisted of mixed timothy and clover. Clover alone made up about 13% and timothy alone made up about 30% of the total acreage.

While barley is grown to some extent it does not cover one-half the acreage devoted to oats. In 1919 there were 17,689 acres yielding a little better than 27 bushels per acre. In 1918 the acreage was over 29,000 and yielded 39 bushels to the acre. In 1917 it was about 19,000 with 36 bushels as the average yield. Barley is grown in all parts of the county and does fairly well on a wide range of soils.

Of the wheat which is being grown, very nearly all of it consists of spring wheat. In 1919 there were 14,948 acres of spring wheat and only 396 acres of winter wheat. The yield of spring wheat was only 15 bushels to the acre, while the winter wheat yielded 24 bushels to the acre. In 1917 spring wheat yielded about 23 bushels per acre and winter wheat, 24 bushels. Wheat is confined to the heavier soils of the county, and it does very well on the Miami silt loam. It is also grown quite extensively on the prairie types.

Rye is grown to a limited extent, and in 1919 there were 2,318 acres having yields of 18 bushels per acre. The yield the previous year was 24 bushels per acre. Rye is confined chiefly to the northern part of the county and is grown most extensively on types of a sandy nature.

Potatoes are grown chiefly for home use, and as a rule there are very few produced on a commercial scale. In 1919 there were 1,839 acres, which yielded only 61 bushels per acre. In

1918 the yield was 84 bushels per acre and in 1917 it was 99 bushels per acre. Potatoes make good growth on the light-colored sandy soils, although they are not confined to the sandy types by any means. One of the finest fields that was ever seen was grown on Waukesha silt loam. In this field there were 100 acres, and the average yield was 150 bushels per acre.

Alfalfa is coming to be a very important crop in Walworth County, although the present acreage is not large. In 1919 the reported acreage was 2,933 acres which produced an average yield of 2.8 tons. Alfalfa is grown in most parts of the county, but appears to do best on the Miami soils. These are very well drained and the structure of the subsoil is such as to permit the easy development of the large root system. The deep subsoil of these types also contains considerable lime carbonate which is favorable to the growing of alfalfa.

Peas are grown both for seed and for canning. In 1919 there were 148 acres that were allowed to mature, and the average was 15 bushels per acre. During the same year 417 acres were used for canning purposes. There are several canning factories in the county, and these usually have branch viners scattered throughout a considerable territory. The farmers bring the peas to the viner. They furnish the power for operating the viner, and the company hauls the shelled peas to the central canning plant from the viner. Where the farmers furnish the power and labor for running the viners, the viners are returned to the farmers for feed and silage. Where the canning company furnishes all of the labor and power they retain the vines for silage and sell them back to the farmers. The vines are usually put up in the form of silage and utilized during the late summer and early fall as feed. The varieties of peas grown for canning are the Alaska, which is a very early variety, Perfection, which is medium early, and Horsford, Rose Garden, and Peerless, which are late varieties. The yield of peas for canning usually averages from 1,500 to 1,800 pounds per acre, though 3,000 pounds per acre are not uncommon. The average income is from $50 to $60 per acre, though returns of $100 per acre are not uncommon.

Inoculation is practiced in growing peas to some extent, but the practice is not general. It is believed that the inoculation will pay on all new land and will insure a better stand and

bigger yield. Many also consider it advisable to inoculate old land, especially where peas have not been grown before. It is a poor policy to grow peas on the land more than two years in succession, but it is better to grow them for one year, and then other farm crops, haing peas as one member of the regular rotation. A rotation which was found to be practiced to some extent with peas consisted of hayland which was top dressed with manure in the fall or winter and in spring plowed for corn. If corn had occupied the field for one year, peas would be grown followed by buckwheat, although the practice of growing buckwheat is not very common. The next year the field was again devoted to peas followed by small grain, seeded to clover and timothy. The peas are sown at frequent intervals so that the crop will not mature all at the same time. By sowing at intervals and using different varieties the period of harvesting can be spread out over several weeks.

Peas are grown on quite a variety of soils, although the Miami silt loam doubtless gives best results. When grown on the dark-colored soils and those especially high in organic matter, there is danger of the vines becoming too large. The Carrington silt loam, however, is used quite extensively for the growing of peas in some parts of the county.

In connection with the canning industry sweet corn is also handled by some of the same factories which can peas. The Evergreen is an early variety of sweet corn, and the Shoepig is somewhat later. The average yield of snapped ears per acre runs from two to three tons. When the ears are snapped the stalks are usually used for silage. This sweet corn is grown chiefly on the Carrington silt loam, although it is not confined to this type.

Marsh hay is another crop that is harvested, but no thought need be given to its cultivation. In 1919, 5,571 acres were harvested, yielding an average of 1.4 tons per acre.

Cabbage is one of the special crops and 141 acres were devoted to it in 1919. Sugar beets were grown on 194 acres, flax on 55 acres, tobacco on 6 acres, and beans on 10 acres. Sorghum is grown to a very limited extent, and the acreage does not seem to be increasing.

The production of fruit is limited chiefly to apples and small bush fruits, including berries. There are few commercial orchards, but nearly every farmer has a few trees on which

apples are grown for home use. The bush fruits appear to do very well and are grown for home use in nearly all parts of the county. The trucking industry has not developed to any marked extent in this county, chiefly because of its distance from large centers of population. There is some trucking around the small towns, but this is only a comparatively small acreage. Near Lake Geneva celery is being grown on marsh land and shipped to outside points as well as being marketed at home.

A large proportion of the crops grown in the county are marketed in the form of dairy products, as pork and beef Some hay is sold, but by far the greater proportion is fed on the farms as is also the case with the barley, oats, and corn.

ADAPTATION OF CROPS TO SOILS

It is generally recognized by practically all farmers that some crops are better adapted to certain soils than other crops, and there has been a gradual development along this line so that the crops which are most extensively grown on the various types at present are those which are most suited to those soils. This fact, however,must be kept in mind that on any farm it is desirable and necessary to raise different crops in order that various feeds may be produced; that rotations may be practiced and the best methods of soil improvement followed. It is evident, therefore, that no one crop can be grown exclusively on soil which may seem to be best adapted to that crop. It is generally recognized that the prairie soils are well adapted to corn production. Yet it is not considered advisable to grow corn to the exclusion of other crops on this land. The Clyde silt loam when thoroughly drained is one of the best corn soils in the state. Yet even on this soil other crops should be grown in rotation with corn. Such crops as rye and potatoes are grown more extensively on the sandy types than on the heavy soils. It is a generally admitted fact that small grains will produce a higher quality on the light-colored heavy soils than on the prairie lands, and there is also less danger from lodging. It is also true that when sugar beets are grown they have a slightly higher sugar content when raised on the light-colored heavy soils than when grown on the prairie soils or Clyde silt loam. However, the tonnage is usually larger on such soils as the Clyde silt loam, so that the total sugar yield is frequently larger on the dark colored soil. Farmers in general recognize

that soils of Miami and Rodman series where not too rough are well suited to alfalfa because of the large amount of lime which they contain. There is still much to be learned, however, in regard to the adaptation of crops to the different soils, and it would be well for every farmer to make observations relative to the behavior of different crops and different varieties upon the various soils, and to be guided as far as practical by the results of these observations.

METHODS

The methods of farming which are being followed in Walworth County at present are such as tend to the higher development of agriculture through the conservation of soil fertility. Gradually people are coming to recognize the importance of conserving the fertility and of following such methods as will permanently increase the productivity of the soil. Many farmers are taking advantage of the service offered by the Wisconsin State Soils Laboratory which makes it possible for any farmer to have a careful examination made of the soils of his farm. The results of chemical analysis and physical examination of the farm provide the information as a basis of a report outlining methods for the improvement of soils. As a result of this line of work many farmers are beginning to use lime to correct the soil acidity and are using such fertilizers as are necessary to supply the elements which the soil most needs. More care is being used in the conservation of stable manure, and this is often being applied to the land as rapidly as it is produced.

In connection with the handling of the corn crop which is one of the most important crops, it may be said that usually over 50% of this crop is put into the silo, the remainder is usually husked, but a small part is harvested by stock and is frequently referred to as "hogging off" corn. Sometimes cattle are also turned into the field and allowed to harvest the crop in part. When this is done cattle are usually followed by hogs.

In connection with the raising of grains many farmers thresh directly from the field, while others stack the grain and thresh later in the season, and some store the grain in barns and do not thresh until late in the fall.

COMMERCIAL FERTILIZERS AND MANURES

Analyses of the soil of Walworth county show that much of the land is somewhat deficient in phosphorus as is true of many Wisconsin soils. The light colored upland types are low in nitrogen and organic matter, the black prairies are usually acid and in need of lime and the peat marshes are low in both potash and phosphorus but are usually not acid.

The correction of these defects is a very important problem which cannot be solved except after making a very thorough study of the soils and types of farming followed.

The chemical and physical analyses show that these soils vary greatly in their composition and they also vary greatly in their needs. Some require all three of the most essential elements of plant food to keep up their productivity as well as lime, while others require only one element. As compared with other soils of the state the land in this region may be considered of very good quality and no more in need of fertilization than the other highly developed agricultural regions of the state. To correct minor defects, however, and to keep up and increase the fertility certain lines of improvement should be followed.

In supplying fertilizer materials to the soil the most economical sources available should be drawn upon The most common source of fertilizer for the farms is stable manure. The supply of this is greater in a dairy region than in a grain raising region, but even here the supply is not sufficient to meet the needs of the land.

The readily available plant foods in the form of commercial fertilizers are now being used to some extent in this region. In 1919 there were 149 farms reporting the use of commercial fertilizer and for this the sum of $15,293 was expended. In 1919 there were 2,195 farms reporting expenditures for feed, with a total cost of $1,017,947. Much of this money could be saved by the judicious use of fertilizers and the growing of such crops as alfalfa which have a high feeding value equal to wheat bran.

The analysis of the soil will give some indication as to the need of certain fertilizers, but the growth and behavior of the crop itself will be a more certain guide as to the needs of the soil.

From soil analysis, crop studies, and field tests it has been clearly demonstrated that one element in which many of the soils is deficient is phosphorus. This can best be supplied in the form of acid phosphate, which is readily available, or it may be applied in the more slowly available forms of raw rock phosphate or bone meal. In the trucking region where crops are forced, and where large amounts of readily available plant food must be at hand the complete fertilizers are most commonly used, and applications run as high as 1,000 pounds per acre or more. Frequently liberal applications of mixed fertilizers are used to supplement stable manure, and it is usually such combinations which produce the largest and most economical yields. In the improvement of the peat marshes potash alone is required first, but after a number of years cultivation it is probably that phosphorus will be needed also. This is especially true of the marshes which do not need lime. Where lime is needed, usually potash and phosphorus are both required.

For general farm crops the usual application of acid phosphate is from 300 to 400 pounds of 16% material per acre when sown broadcast. If applied in the row or hill about half this amount is sufficient. Subsequent applications should be at the rate of about 200 pounds every three or four years thereafter.

The most satisfactory way to apply commercial fertilizers is with a fertilizer spreader, or with a fertilizer attachment to a grain drill, or corn planter. If sown broadcast it should be put on the plowed ground, evenly distributed and worked well into the soil. Care should be taken that it does not come into contact with the seed. Commercial fertilizers may also be applied by spreading them over the top of a load of manure in the manure spreader. An application should be made at least once during each rotation, and preferably on the small grain crop, or on the corn. Frequently both of these crops are given an application.

In supplying nitrogen to the soil, the most economical form is through the growth of legumes.

For more information on The Use of Commercial Fertilizers on Dairy Farms, see bulletin No. 341, Wisconsin Experiment Station.

LIMING

Walworth County is located within the glacial limestone region of Wisconsin, and a considerable proportion of the soil forming material has been derived from limestone debris. The deep subsoil of many of the types is well supplied with lime and the surface soils in many places is neutral or only very slightly acid. In fact, many tests have been made where the soil does not show any reaction whatever. The types which are most apt to show acid reaction and which seem to be in need of lime are soils of the Carrington and Waukesha series. The soils of the Miami series also show slight acidity in places. The peat soils are also slightly acid in places but there is less acidity in the low lands of this region than in the central and northern parts of the state.

The degree of acidity on any farm may be quite variable. It is quite important therefore that before an expenditure is made for lime that the soil should be tested and the crops observed to determine the actual need for lime.

It should be kept in mind that when a soil is acid according to a laboratory test, it does not necessarily mean that that soil will respond profitably to the use of lime. The story which the crop tells should also be considered. Failure of clover and alfalfa, or a growth of sorrel may be indications of acidity. When there appears to be a medium need for lime, from 2 to 3 tons of finely ground limestone should be applied per acre. The amount to be used will usually vary with the degree of acidity, the character of the soil and the crops to be grown. Such crops as alfalfa, sweet clover, peas, cabbage, onions, and lettuce have a high lime requirement. Clover, garden beans, barley, hemp, turnips, and radishes have a medium lime requirement, while vetch, white clover, oats, rye, blue grass, potatoes, sorghum, and others have a low requirement for lime.

Ground limestone appears to be the most economical form of lime which can be extensively utilized. Lime should be applied previous to planting the crop which is to be benefited. It should be applied to plowed land and thoroughly worked in by harrowing. Either fall, winter or spring applications may be made.

The best way to apply lime is with a regular spreader made

for this purpose, and there are a number on the market. A manure spreader may also be used by first putting in a thin layer of manure and spreading the limestone evenly on top of the manure. Where several farmers are so situated that they can work together, a lime spreader may be secured jointly for this purpose. The end-gate type of spreader has given good results in spreading dry or moist limestone.

After making a first application of two tons or three per acre, it is not likely that another application will be needed for four to six years, and the need should be determined by the story which the crops themselves tell.

It should be remembered that most acid soils are also deficient in available phosphorus,* but applying lime will not add to the total amount of phosphorus in the soil. The need of phosphorus may be so great that but little result will be secured from liming until phosphorus is also added. Frequently the application of phosphorus alone to an acid soil will result in larger increases than the use of lime alone, and for this reason it is important that both deficiencies should be corrected to secure the most economical production.

Several demonstration plots on which lime and phosphate fertilizers were tried out in Walworth county bring out the relation between the needs of lime and phosphorus. In several instances it was observed that where lime alone was applied to Carrington silt loam, for example, that there was no increase in yield, but where acid phosphate was also added a very liberal increase in yield was secured. The acid phosphate when used alone did not give so great an increase. It is apparent, therefore, that these materials must sometimes be used together, and the only way to determine this accurately is by actual field tests.

DRAINAGE

Walworth County has over 80,000 acres of land over which the natural drainage is deficient, according to the classification of the soil survey, and which must be provided with some form of drainage before cultivated crops can safely be grown from year to year. Of this poorly drained land possibly 50% consists of peat, while most of the remainder is low, poorly drained mineral soil which belongs chiefly to the Clyde series.

* For a discussion of the use of commercial fertilizers see page 82.

The largest proportion of the Peat marshes are confined to the north half of the county, while the areas of Clyde soil are pretty well distributed over the county.

The following table taken from the 1920 census gives statistics covering the extent to which the development of drainage enterprises have been carried in this county.

Drainage Statistics for Walworth County, Wisconsin

	Acres
All land in operating drainage enterprises	8,910
Improved land in drainage enterprises	4,048
Open ditches completed. Miles	23.3
Tile drains completed. Miles	7.5
Maximum size of tile, diameter in inches	14.0
Area drained by open ditches and tile drains. Acres	3,820
Area on which corn was chief crop grown on reclaimed land	4,048

It will be observed from this table that there are nearly 9,000 acres in drainage enterprises and that about 30 miles of drains, open and tile, have been constructed.

The types which offer the best opportunity for drainage from the standpoint of productivity are the soils of the Clyde series. When well drained these soils make the best corn land in the State, and they are also well suited to cabbage, sugar beets and hay. On the lighter soils of the series onions will do very well, though not grown in the area to any extent at present.

The drainage of the peat land offers opportunity of agricultural development, but the problems in the improvement of this type of land are more numerous and difficult than is the case with the Clyde soils. The peat requires the use of commercial fertilizers, as indicated elsewhere and special methods of cultivation are also called for, but with proper handling peat lands can be made to produce profitable crops, and their drainage will add materially to the productive acreage within the county.

If all of the poorly drained land of the county were improved so that the gross income would be only $10 per acre there would be added over half a million dollars to the farmers annual income. Such an important project is worthy of the most careful study by every public spirited citizen of the region. The best results can be secured only through cooperation of all parties concerned.

Where areas of low land include land owned by several

people the owners can readily form a drainage district and issue bonds for the improvement. This is the method which has been used and a number of drainage districts have already been formed in Walworth County. In this way the cost can be spread over several years, and can actually be paid for from the products of the improved acres. Assistance for the development of such projects can, and in fact must, be secured from the State authorities, who pass upon the feasibility of the project before the courts will permit the organization of a district. Where areas of marsh are small and confined to one farm from which there is an outlet the drainage can be installed without the cooperation of the neighbors. This has been done in a number of places, and small tiling systems are not uncommon in Walworth County. There are thousands of acres in small tracts which have not as yet been improved, but which would make good productive land when drained.*

EQUIPMENT

Most of the farms in Walworth County are very well kept. The farm buildings are usually quite substantial. The barns are large, usually built on stone foundations, and are kept painted and in good repair. The farm houses are neat and attractive in appearance. Many of the farms are equipped with silos, and in 1918 there were 793 in the County. In 1921 there were 2262 silos. Farm machinery of the most modern types is in common use throughout the county. There are many tractors in use, manure spreaders, hay loaders, side delivery rakes, two-row cultivators, lime and fertilizer distributors, and other modern implements. In 1921 the number of tractors in the County was 345 and they are gradually increasing in number. The live stock upon the farms is, as a rule, well bred, and there are many herds of pure bred live stock throughout the County.

A number of dairy farms are equipped with milking machines. Electric lighting plants are common and many farm houses have furnace heat, running water and are as modern in their equipment as the houses in the cities. Nearly every farm has a telephone, an automobile and rural free delivery service reaches all parts of the County.

* For additional information on drainage see Bulletins of the Wisconsin Experiment Station No. 284 and 309.

Walworth County as a whole is a region of high agricultural development and highly developed and prosperous farms are the rule rather than the exception.

LABOR, FARM TENURE AND LAND VALUES

The question of farm labor is one which has been rather difficult in the last few years. With the development of manufacturing in Racine, Kenosha, Beloit, Janesville and Milwaukee, there has been a gradual drawing away of labor from the farms. The highest point in farm wages was reached in 1920 when as much as $60 to $70 per month and, in some cases, even $100 was paid. In 1921 there was a marked decrease in the farm wages. The pre-war wage was usually from $35 to $50 per month for the best farm labor when secured by the year, and frequently included house and garden for the married help. Day labor, of course, commanded a larger wage, but was needed for only a part of the season. It may be said that the raising of pure bred live stock requires a higher grade of labor than where a system of purely grain farming is followed.

In 1920 the average size of farms in Walworth County was 118.8 acres per farm, and there were at that time 2803 farms in the county. In 1910 there were 64.4% of the farms that were operated by the owners. In 1920 there were 66.2% of the farms that were operated by the owners. This is a much smaller number than was operated by the owners in 1880, since at that time 86.4% of the farms were operated by the owners. In Walworth County, and especially in the region of Lake Geneva and Delavan Lake there are a large number of farms owned by non-residents, chiefly wealthy people from Chicago and elsewhere who have their summer homes in this region, and many of them own and operate under a manager considerable tracts of land. Many of these places are very highly developed. The farms which are operated by tenants are worked both on the share and on the cash basis. The share which the tenant receives is quite variable, depending on the amount of stock and equipment which he furnishes. The share usually ranges from a third to a half, sometimes less where the owner furnishes all the stock and equipment.

There is a wide range in the selling price of the land in Walworth County, due to the valuation of the land itself and also to location and improvements. Some of the best farms which

do not have a location making them valuable as summer homes have a selling value of as much as $200 or $300 per acre, though this is higher than the average for the farms in any community. The other extreme is found in the land within the extremely rough and hilly sections where land can be purchased from $25 to $50 per acre. Between these extremes all variations in land values may be found. The land near or adjoining the lakes frequently has a much higher selling price, due to its desirability for summer homes and being especially attractive to non-resident people who have farming ambitions and wish to combine them with recreation. The average assessed valuation of farm land in Walworth County in 1900 was $48.26 per acre. In 1910 this was $69.38, and in 1920 $116.14. The average value of farms in 1880 was $5,030 and in 1890 this was $7,000. In 1900 it had increased to $8,928. In 1910 the average value per farm was $13,265, and in 1920 it was $22,672. The following table gives information concerning the farm values and tendancy as found in the U. S. Census.

FARM AREAS

Value and Tenancy—Walworth County
(U. S. Census)

	1880	1890	1900	1910	1920
Population of County			29,259	29,614	29,327
Number of Farms	2,761	2,660	2,754	2,803	2,779
Average Size of Farms	121A	124A	123A	120A	118.8
Percentage of Land in Farms	93.4	92.5	95.1	94	92.1
Valuation per Acre			$48.26	$69.38	$116.14
Percentage of Farms operated by Owner	86.4	75.27	69.1	64.4	66.2
Value of all Property per Farm	$5,030	$7,000	$8,928	$13,265	$22,672

CROP ROTATIONS

It is of great importance in selecting crops to grow, that careful consideration be given to the question of climate. This is about the only factor which the farmer absolutely cannot control. A poor soil may be improved, better markets may be found, and better labor secured, but the farmer is powerless to change climatic conditions. He must, therefore, select such crops as are suited to his climate.

The soil is also a factor of great importance. As a general

rule, small grain crops do better on heavy than on light soils, and the same is true of grasses grown for hay. On the other hand, the same variety of corn requires shorter season for maturity on light than on heavy soil. Rather light soils and those of intermediate texture are better adapted to potato growing and root crops. Therefore, on lighter soils the greater acreage should be devoted to cultivated crops than on heavy types.

Shipping and marketing facilities must also be considered in planning a rotation. The farmer located on a sandy loam farm close to a railroad station or home market will often find it profitable to include potatoes in his rotation. If he is located six or seven miles from a station, the profits from growing potatoes will be much lessened. It will then pay him better to raise more corn for stock feeding, and to convert his crops into dairy products which are less bulky, and which for the same bulk have a greater value.

Some of the other things which we should keep in mind regarding a good rotation are that it helps to control weeds. It also aids in controlling plant diseases, and serves to check insect pests. Following a good rotation increases the humus supply in the soil, and insures maintaining a good amount of available nitrogen in the soil. It helps to distribute the labor efficiently throughout the year. It will also increase net returns from each acre, and improve the general appearance of the farm.

The rotation of crops which is most common probably consists of corn, followed by small grain, which is seeded to timothy and clover, after which hay is cut for one or two years. Corn may be grown on the same field for two years in succession, especially on the prairie soils, or the second year may be devoted to peas instead of corn, but usually on a much smaller acreage. Small grains may also be grown for two years in the rotation. The manure is most frequently applied to the corn ground and this is frequently plowed in the fall. The manure is sometimes spread on the plowed ground in the winter or on the land which is to be plowed in the spring. The question of rotations is receiving more careful attention now than in previous years, and most farmers follow some sort of a rotation, though not always the one most suited to their particular soils.

Potato raising when properly managed is a profitable industry in many parts of the state. Although good crops may be grown on heavy soils, the sandy loams are especially well adapted to potato production. For best results, this crop should be grown in rotation with other crops, and should always follow a legume of some kind. Potatoes should not follow corn or corn potatoes as both crops draw heavily on the fertility of the land. In the rotations which have been given, potatoes can be planted as one of the cultivated crops. It is better to apply manure to the cloer crop rather than just before planting to potatoes, for scab is more common when potatoes are planted on freshly manured land. The three-year rotation just described is excellent for sections where potatoes are grown extensively. As a rule cropping to potatoes oftener than once in three years is not recommended.

The growing of peas for canning is important in some sections, and this crop may be introduced into the rotation very readily. A four-year rotation may consist of small grain, clover, a cultivated crop, followed by peas This may be made a five-year rotation by adding timothy and cutting hay two years.

The growing of sugar beets is also an important industry, and beets may also be introduced into the rotation without difficulty. It is best not to have the beets follow or precede the corn, but the crop may follow barley or other small grain. Beets may simply take the place of corn in a three or four year rotation, Cabbage may be substituted for beets without difficulty.

Hemp is an important crop in Wisconsin and could be grown in Walworth county as it is now being grown in Racine and Kenosha counties. The most satisfactory place in the rotation for this crop is after corn. The corn should have been preceded by clover sod, well manured and plowed in the fall. Hemp may also follow potatoes, cabbage, or any other cultivated crop. Hemp should not follow timothy meadow, blue grass sod nor pasture in Wisconsin. Neither should hemp follow any small grain unless the soil is very well supplied with manure. Hemp will leave the soil in splendid physical condition for any spring sown small grain. It also leaves the land relatively free from weeds, and it is, therefore, a good crop to precede sugar

beets, or canning peas. The following rotations with hemp have been found applicable to Wisconsin:

Small spring grain crop (seeded down to clover)
Clover for hay and pasture (manured and fall plowed)
Corn, potatoes or similar crops
Hemp (then back to small grain and clover)

Another rotation covering three instead of four years is as follows:

Small grain crop (seeded to clover)
Clover (manured and fall plowed)
Hemp (then back to small grain and clover)

AGRICULTURAL HISTORY

The agricultural history of Walworth County dates back to 1836 when the first farm operations were started in Section 25, in Spring Prairie township During that year about 100 acres were plowed. Before the end of that year there were in the county about 100 head of cattle, 50 sheep, and a few hogs. The first farm operations were started on the prairie land where practically no clearing operations were necessary. Early historical references indicate that at another point where farm operations were started early was the prairie in Walworth township. Here the first plowing operations were on a rather extensive scale, and fields fully two miles in length were laid out.

The crops most extensively grown in the early history of the county are indicated by the following report covering the year 1839. During that year wheat was produced to the extent of 59,580 bushels; barley, 1,499 bushels; oats, 25,155 bushels; rye, 205; corn, 40,837; potatoes, 42,455; and hay, 3,624 tons.

The population in 1839 was 2,611. Because of the marked fertility of the soil in this region and the success with which the early settlers met, settlement became quite rapid as soon as information concerning the bountiful crops reached the surrounding territory, and by 1842 the population had reached 4,618 By 1880 the population had increased to 22,632. Between these two dates there was a rapid growth not only in the population, but in the amount of land under cultivation. Since 1880 the population has remained nearly the same as has also the number of farms in the county.

There has, however, been a considerable change in the

acreage of the different crops which have been and which are now being grown. In 1879 wheat was grown on 26,080 acres, and since that time the acreage has gradually been reduced. In 1889 it amounted to 13,302 acres, and in 1899 to 1091 acres. In 1909 it was 664 acres. On the other hand the acreage of corn, while relatively large in the early history of the county has always remained high, as has also the acreage of oats. The reduction in the acreage of wheat was partly due to the cinch-bug and partly to low prices. As the acreage of wheat was reduced a more diversified system of farming was followed.

The first railroad was built through Walworth County in 1851. This was a part of the line now known as the Chicago, Milwaukee and St. Paul, and was completed from Milwaukee to Prairie du Chien in 1856. The line which is now the Chicago and Northwestern connecting Racine and Beloit was completed in the county in 1856.

CLIMATE

Walworth County is practically all included within the Rock River Basin, which is one of eight climatic provinces in Wisconsin.* This section has the longest growing season of any in the State, averaging about 170 days, which is as long as that of central Illinois, longer than central Indiana or Ohio, and about equal to the Valley of Virginia and central Maryland. The annual temperature curves also show here a northward bend and though the winters (20 degrees) are cooler than along the lake, the springs (45 degrees) and summers (70 degrees) are warmer. Hence this section is the best corn area in the state. The temperature of the Rock River basin in summer is similar to that of northern Illinois, Indiana, Ohio and southern Pennsylvania, while in winter it resembles southern Vermont, northern Iowa, or southern Montana. During seven summer days, on the average, the thermometer may go as high as 90 degrees and during five winter mornings fall 10 degrees below zero or lower. The average rainfall ranges from 31 inches at Madison to 33.77 inches at Brodhead.

The mean annual temperature at Delavan is 45 degrees. The rainfall is 31.4 inches. The absolute maximum temperature is

* For full information on the Climate of Wisconsin and its relation to Agriculture see Bulletin of Wisconsin Experiment Station, No. 223.

103 degrees and the minimum is 29 degrees below zero. Extremes as marked as these are infrequent and of short duration.

The records at Delavan show that the average date of the last killing frost in the spring is May 17 and the average date of the first killing frost in the fall is October 6. This gives an average growing season at Delavan of about 142 days which is somewhat less than for the climatic province as a whole.

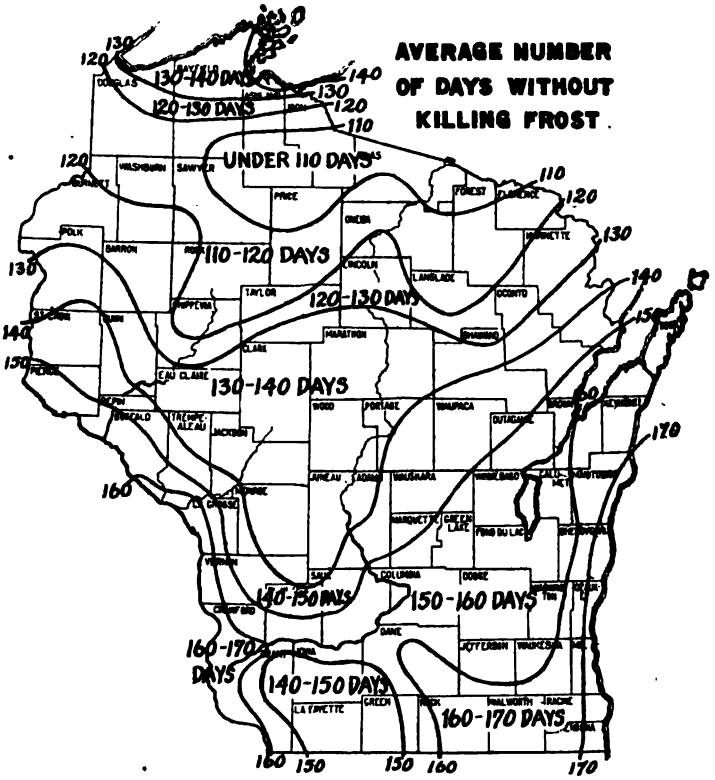


FIG. 3—SKETCH MAP OF WISCONSIN SHOWING THE AVERAGE NUMBER OF DAYS WITHOUT KILLING FROST

The average rainfall is normally well distributed throughout the year and especially during the growing season when most needed. The average for the three spring months is 8.56 inches, for the summer 10.80 inches and for the fall 8.07 inches. It is true, however, that during July and August there are occasional dry spells during which crops actually suffer from the lack of moisture. Dry spells may occur in the fall also, but as crops reach or approach maturity, a reduction in the

supply of soil moisture is not so serious a matter as when the plants are making the main part of their growth. While these dry spells frequently cause a reduction in the yields, they have never been so severe as to cause even an approach to a crop failure.

In the following table are shown the more important climatic data as compiled from the records of the weather Bureau station at Delavan.

NORMAL MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT DELAVAN, WALWORTH COUNTY

Elevation of Station 920 Feet Above Sea Level

Month	Temperature			Precipitation		
	Mean	Absolute Max.	Absol'te Min.	Mean	Snow-fall	Prevail, wind
December	23.9	62	—27	1.49	--------	S. W.
January	18.4	59	—28	1.43	--------	S. W.
February	20.1	58	—29	1.25	--------	N. W.
Winter	20.8	62	—29	4.17	--------	--------
March	32.2	82	—20	1.84	--------	S
April	46.1	88	15	2.87	--------	N. E.
May	57.1	93	22	3.68	--------	S. W.
Spring	45.1	93	—20	8.56	--------	--------
June	66.7	99	30	3.56	--------	S. W.
July	71.9	103	40	4.04	--------	S. W.
August	69.5	101	34	3.20	--------	S. W.
Summer	69.3	103	30	10.80	--------	--------
September	62.4	99	24	3.96	--------	S. W.
October	49.3	89	2	2.23	--------	S.
November	34.8	77	—15	1.88	--------	S. W.
Fall	48.8	99	—15	8.07	--------	--------
Year	46.0	1030	—29	31.40	--------	S. W.

FROST DATA AT DELAVAN, WIS.

Average date of last killing frost in spring.....May 17
Average date of first killing frost in fall.....October 6
Latest date of killing frost in spring.....June 8
Earliest date of killing frost in fall.....September 10
Average length of growing season at Delavan free from killing frost, 142 days, according to above table.

SUMMARY

Walworth County is situated in the southeastern part of Wisconsin and has a land area of 560 square miles, or 358,400 acres. The area of the lakes within the county amounts to approximately 14 square miles. The southern boundary line of the county is the Illinois-Wisconsin State line, and the eastern boundary is 24 miles from Lake Michigan.

The most important topographic feature within the county is the terminal moraine of the Lake Michigan and Green Bay glaciers. Within this morainic belt the topography ranges from rolling to extremely rough and broken. Outside of this belt the surface of the county ranges from level to gently rolling.

The drainage of the western part of the county is chiefly through Turtle Creek into Rock River. The drainage of the eastern part of the county is chiefly through tributaries of the Fox River which flows south into the Illinois River.

The county was established in 1838, but the first settlements were made in 1836. The population in 1920 was 29,327 of which 69.8 per cent was rural. The entire county is well provided with railroads and public highways, and all sections are well settled.

The climatic conditions are favorable for the high development of agriculture The mean annual rainfall as reported at Delavan is 31.42 inches. There is a normal growing season between frosts of approximately 167 days.

The agriculture of Walworth County consists of general farming in conjunction with dairying. The principal crops are corn, oats, barley, clover, timothy, alfalfa, and wheat. There are other crops of lesser importance and also some special crops, including rye, buckwheat, tobacco, potatoes, sugar beets, peas, and cabbage. Hog raising has been developed quite extensively in connection with dairying, and some beef cattle and sheep are also raised. Stock feeding for market is also practiced in some parts of the county, although not extensively.

Land ranges in value from $25 to $300 an acre. The lowest value is in the extremely rough and broken lands in the morainic belt, and the highest priced farms are on the prairie lands, which are highly developed and very productive.

The soils of Walworth County are derived chiefly from glacial drift, some of which has been worked and redeposited by the action of water. Nine series, represented by 19 soil types, including Peat, were recognized in the soil survey. A number of phases have also been shown.

The Miami series includes light-colored upland forest soils in the glaciated limestone region. The types in Walworth County belonging to this series are the Miami silt loam with a

deep phase and a level phase, Miami loam with a gravelly phase, Miami fine sandy loam and Miami stony loam. This series includes much first class farm land.

The Coloma fine sand is a light colored, extremely sandy upland soil which has been leached to a considerable extent and is now in an acid condition. This is the only type mapped in the Coloma Series.

The Rodman Gravelly loam occupies rough and broken ranges of gravelly hills which are made up chiefly of kames and eskers. The total area is limited but the contrast between this and other soils is very marked. The agricultural value is low, the soil being droughty.

The Carrington series includes dark colored upland prairie soils in the glaciated limestone region. The surface is level to gently rolling and the natural drainage is good. The soils are highly productive, though usually acid. The types mapped in this series are Carrington Silt loam and Carrington Loam with a gravelly phase.

The Fox series consists of light colored outwash or terrace soils, in the glaciated limestone region. These soils have developed under a forest cover. These soils have sandy or gravelly subsoils at varying depths, and the natural drainage is usually good. The types mapped are the Fox silt loam with a deep phase, Fox loam, with a gravelly phase, and Fox fine sandy loam.

The Plainfield fine sand is a light colored soil, very low in lime carbonate and usually acid, which occurs in terraces or outwash plains.

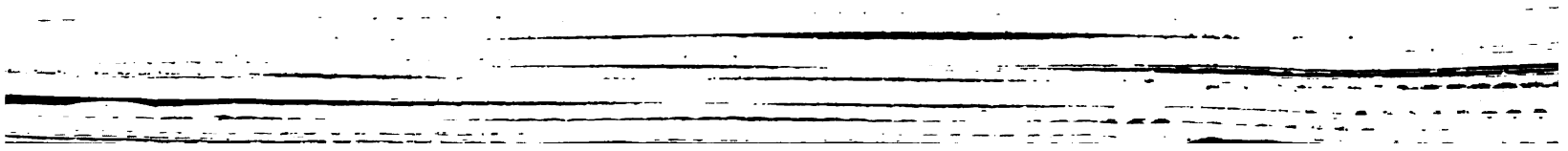
The Waukesha series consists of dark colored prairie soils occupying terraces or outwash plains. The types mapped are the Waukesha silt loam with a deep phase, and Waukesha loam with a gravelly phase.

The Clyde series consists of dark colored low, poorly drained areas in the glaciated limestone region. Some of the material occurs as depressions in the glacial drift and some occurs as old lake beds or as poorly drained low terraces or outwash plains. When drained these soils make excellent land for corn, and some special crops. The types mapped are the Clyde clay loam, Clyde silt loam and Clyde loam.

The Genesee series includes the first bottom alluvial soils

somewhat variable in texture and subject to annual overflow. Only one type, the Genesee silt loam was mapped.

Peat consists of vegetable matter in varying stages of decomposition, which has mixed with it some mineral matter. Much of the peat contains as much as 80% of organic matter. It has been derived from decaying moss, grasses and other water loving plants. Along with the Peat a Shallow phase was mapped.



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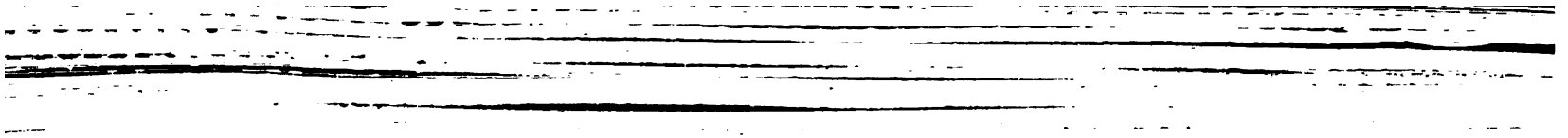

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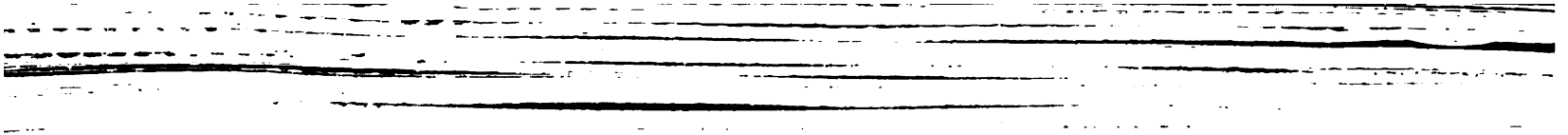

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